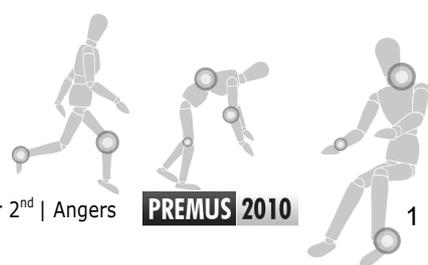


# Table of contents

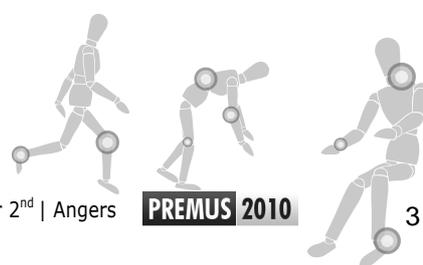
<b>Keynotes.....</b>	<b>13</b>
The evolution of our representations of WMSD: Integrating knowledge and ensuring concerted preventive action .	14
The economics of work-related musculoskeletal disorders: What exactly do we want? .....	17
WMSDs: Knowledge, practice, policy.....	18
Mechanisms in muscle activity: contrasting effects on health .....	20
Lifestyle factors in musculoskeletal disorders (MSDs)– Implications for research .....	22
Prevention of carpal tunnel syndrome: lessons from physiologic studies.....	25
MSD prevention: the organisational challenge .....	27
Management of low back pain and the working environment.....	29
<b>Symposia.....</b>	<b>31</b>
<i>Different aspects of the prognosis of musculoskeletal disorders in occupational settings: example of the carpal tunnel syndrome. ....</i>	<i>32</i>
Epidemiological investigation of prognosis.....	33
In a clinical point of view, what are the strongest predictors of the medical prognosis for carpal tunnel syndrome?.	34
What are the strongest predictors of the medical prognosis of CTS? Results from a US population based study....	35
What are the strongest predictors of the return to work for carpal tunnel syndrome? Results from a French population based study. ....	36
Prognosis for return to work in carpal tunnel syndrome: a north American perspective.....	37
<i>Dynamics of work-related musculoskeletal disorders (MSDs): long-term trends and life course approach</i>	<i>38</i>
Time trends of musculoskeletal pain in a working age population.....	39
Changes in the incidence of occupational disability as a result of back and neck pain in the Netherlands and Ontario, Canada after legislative changes.....	40
Musculoskeletal symptoms during young adulthood predict future unemployment. Results from a 30-year follow-up among Finnish conscripts.....	41
Do health behaviours, social exposures or musculoskeletal health before entering work life predict later musculoskeletal morbidity or sickness absence? .....	42
Physical fitness in adolescence and musculoskeletal sickness absence 5-15 years later: cohort study of 227,201 male employees born in Norway 1967-1976 .....	43
<i>Evaluation of interventions designed to prevent MSD: Theories and strategies .....</i>	<i>44</i>
How “intervention research” could contribute to knowledge on MSDs prevention?.....	45
Evaluation of interventions designed to prevent MSD: what can we learn from successes and failures.....	46
Lessons learned from evaluative research in the field of work rehabilitation.....	47
Randomization, what is it good for? .....	48
How could we improve the generalizability of evaluation results of programs designed to prevent back pain? .....	49
<i>Gender, work activity and MSD: what are the implications for intervention?.....</i>	<i>50</i>
Women in manual materials handling: a complex question.....	51
Results and reflections on gender based ergonomic intervention from the Quebec working group of the IEA technical committee on gender and work (QTC) .....	52
Emergence of the theme of gender in ergonomics: overview of the activities and reflections of the European francophone network of the IEA technical committee on gender and work.....	53
Roundtable on gender-based ergonomic intervention to prevent MSD: issues and implications for implementing changes in the workplace.....	54
<i>Health and safety in the construction industry - Part 1: work demands and related health problems.....</i>	<i>55</i>
Physical demands and musculoskeletal health for bricklayers and construction supervisors – a systematic review	56
Exposure to kneeling work tasks and knee disorders in floor layers .....	57
Factors associated with delayed return to work after back injury among residential union carpenters .....	58
Specific job demands in the construction industry for a pre-employment medical examination .....	59
Work exposures and carpal tunnel syndrome among construction workers.....	60
<i>Health and safety in the construction industry- Part 2: intervention studies .....</i>	<i>61</i>
A health promotion program at the workplace for construction workers: a feasibility evaluation within a randomized controlled trial.....	62
An intervention for overhead drilling to reduce upper extremity musculoskeletal risk factors.....	63
Impact of ergonomic measures on productivity, task demands and workload – examples of two construction jobs.	64
Masonry ergonomics best practices .....	65



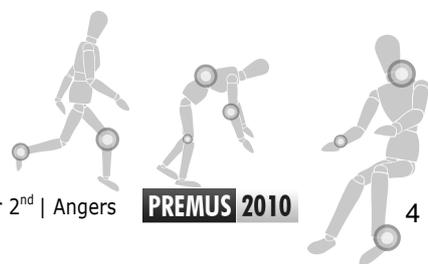
Economic evaluation of interventions to reduce ergonomic injuries in construction .....	66
<i>International perspectives on health-related work outcome measures</i> .....	67
The cross cultural adaptation of the work role functioning questionnaire to Dutch.....	68
The use of work role functioning in evaluating an ergonomic intervention .....	69
Work limitations among workers in a manufacturing company in Denmark .....	70
Measuring work limitations in Brazilian health care workers .....	71
<i>Interventions for reducing work absence for workers with musculoskeletal disorders - innovations and New developments</i> .....	72
Development of the inventory of pain, recovery expectations, and concerns (IPREC): a patient-centered screening tool to match working adults to early intervention for low back pain.....	73
Re-integrating injured workers to the labour market and the problem of poor health .....	74
A multivariate analysis of factors associated with early offer and acceptance of a work accommodation following an occupational musculoskeletal injury .....	75
Assessment of the quality of the return-to-work process among sick-listed workers with low back pain: a focus group study.....	76
Combining disability prevention to return to work management: an innovative step towards better MSD management .....	77
Cochrane review about workplace interventions for preventing work disability .....	78
A systematic review of disability management interventions with economic evaluations .....	79
Coordinated and tailored work rehabilitation: challenges of implementing a cost effective program in an interorganisational setting .....	80
<i>Low back pain: effect of work exposures, lifestyle and individual factors</i> .....	81
Interrelationships between overweight, physical activity and low back pain.....	82
Does obesity cause low back pain? .....	83
The gene-work exposure interaction in causing lumbar herniated intervertebral disc (HIVD) in Taiwan .....	84
<i>Methods for risk analysis in practice</i> .....	85
Ergonomic risk analysis and global company OSH analysis.....	86
The hand arm risk assessment method (HARM), continued development.....	87
The key indicator methods – status quo of a toolbox for risk assessment of physical workload on a screening level .....	88
Promoting compliance with the european directive on manual handling – the use of the manual handling assessment charts (MAC) by regulators and duty holders .....	89
A practical inspection tool for assessment of repetitive tasks of the upper limbs (ART).....	90
Update on the revised NIOSH lifting equation.....	91
<i>Round table: Mobilization/participation of stakeholders for sustainable MSD prevention</i> .....	92
Challenges and facilitators for workplace change using participative ergonomics .....	93
Follow-up of MSD prevention interventions initiated by work inspectors: process and impacts .....	94
Developing the collective activity conditions of occupational health physicians for promoting multidisciplinary in MSD prevention .....	95
Action-training of worker representatives: a contribution to prevention of work-related diseases .....	96
Integration of ergonomics in a continuous improvement approach: goals and involvement of the main stakeholders .....	97
Prevention of MSDs: how OHS practitioners use their resources to become political navigators and improve work situations .....	98
<i>Multisite pain: risk factors and consequences for work ability</i> .....	99
Prevalence of multisite pain, their determinants, and impact on health-related quality of life among Finnish young adults.....	100
Reciprocal associations of psychosocial factors at work with multisite musculoskeletal pain: a two-year follow up study among kitchen workers.....	101
Multisite pain: risk factors and consequences for work ability .....	102
Low back pain, neck pain and their co-occurrence as predictors of sickness absence among municipal employees .....	103
Persistent multisite pain and incident disability pensions among municipal employees .....	104
Influence of fibromyalgia - like symptoms on early retirement and mortality: a twin cohort study.....	105
<i>Musculoskeletal disorders and ergonomic challenges in modern dairy production: European and US perspectives</i> .....	106
European and US dairy production: challenges of work-related musculoskeletal disorder prevention.....	107
Musculoskeletal symptoms among US and Swedish dairy workers.....	108
Quantifying physical work load in different milking practices.....	109
Median nerve entrapment at the elbow level – pronator syndrome - a follow up study after surgical release.....	110



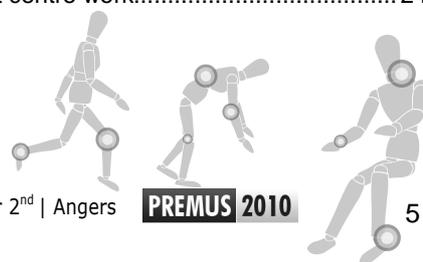
Carpal tunnel syndrome among US dairy parlor workers .....	111
<i>NIOSH upper extremity musculoskeletal disorder consortium studies</i> .....	112
Carpal tunnel syndrome at 3 workplaces – job and individual factors .....	113
Prospective study of rotator cuff, epicondylitis and carpal tunnel syndrome in 12 US workplaces .....	114
Workplace and individual factors and wrist tendonitis: the San Francisco Study .....	115
Risk factors for lateral epicondylalgia from a 7-year prospective cohort study .....	116
Individual, psychosocial and job physical risk factors for CTS: results from a 7-year prospective cohort study .....	117
Risk factors for incident carpal tunnel syndrome: results of a prospective cohort study of newly-hired workers .....	118
<i>Oxygenation and hemodynamics for repetitive work and muscle pain</i> .....	119
Gender differences in the forearm for the oxygenation and myoelectric activity relation, muscle blood flow and oxygen consumption .....	120
Significance of muscle oxygenation levels for fatigue development during submaximal contractions .....	121
Circulatory and electromyographic responses to physical effort and experimental pain in subjects with trapezius myalgia .....	122
Pain during office work: neck/shoulder pain and trapezius muscle blood flux during an experimental work session .....	123
Forearm oxygen delivery, consumption and blood flow before and after fatigue in subjects experiencing work related muscle pain and healthy controls .....	124
Optical spectroscopy derived oxygen saturation responses of forearm muscles in healthy male workers during an eight hour exposure to a repetitive ulnar deviation task .....	125
<i>Pain and movement</i> .....	126
A review of epidemiological evidence for relationship between physical work load and musculoskeletal disorders .....	127
Work-work-work: individual joint- and whole-body changes associated with repetitive motion-induced fatigue .....	128
On the transition from acute to chronic neck-shoulder pain in repetitive work .....	129
Motor performance in chronic low back pain .....	130
Trapezius activity distribution: relevance for pain? .....	131
<i>Rationalization trends in working life: challenges and opportunities to create sustainable production systems</i> .....	132
Occupational musculoskeletal and mental health: significance of rationalization and opportunities to create sustainable production systems – a systematic review .....	134
Lean production and work-related musculoskeletal disorders, WMSDs .....	135
Workplace intervention effects: organizational level discrepancies and interferences? Preliminary results from a study of 6 units within the home care services in Trondheim, Norway .....	136
Impact on working conditions, productivity and health of dentists – a prospective study during rationalizations in public dental care .....	137
Rationalization in public dental care and impact on biomechanical exposures for dentists – a prospective study ..	138
Consequences on physical workload of rationalization in meat cutting .....	139
Rationalization as a determinant of mechanical exposure – case studies of parallel and serial flow production in two auto branches at different levels of industrialization .....	140
A tool for development of sustainable health care systems by integrating considerations for performance and job content .....	141
Sustainable MSD prevention: management for continuous improvement between prevention and production. ergonomic intervention in two assembly line companies .....	142
<i>Round table discussion part I. Classification of musculoskeletal disorders in occupational health practice and research: when is preventive action in OH required? and distinguishing between normal and serious symptoms</i> .....	143
<i>Round table discussion part II. Classification of musculoskeletal disorders in occupational health practice and research: needed in the future to address sustainable musculoskeletal health and related work ability?</i> .....	144
<i>Surveillance of work-related musculoskeletal disorders: how? by an for whom? how is it linked to prevention?</i> .....	145
Work-related musculoskeletal disorders (WMSD) surveillance and Quebec's public health strategy to prevent WMSD: realizations and challenges .....	146
Using workers compensation data for WMSD surveillance .....	147
French epidemiological surveillance program of work-related musculoskeletal disorders: strengths and challenges .....	148
<i>The role of self-efficacy in the disability prevention framework and the return to work process</i> .....	149



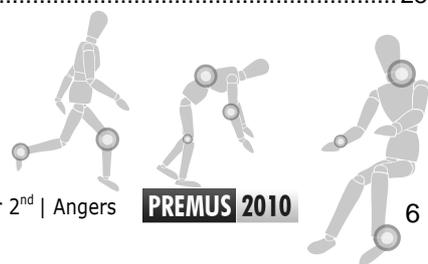
Development of the return-to-work self-efficacy (RTWSE) questionnaire: psychometric properties and predictive validity .....	150
General and specific self-efficacy reports of patients with chronic low back pain: are they related to performances in a functional capacity evaluation? .....	151
Association between self-efficacy and readiness for return-to-work in a cohort of injured workers with work-related musculoskeletal conditions.....	152
The role of organizational policies and practices in effecting self-efficacy in return to work following carpal tunnel surgery .....	153
<i>The worksite as arena for health enhancing interventions. Lessons learnt from recent and current RCT studies.....</i>	<i>154</i>
Integrated health programme: a workplace randomized controlled trial.....	155
Telemedicine applications offering treatment in home/work situation for people with musculoskeletal pain .....	156
Interventions aiming at preserved work ability among employees in job groups with high physical demands, FINALE .....	157
Musculoskeletal disorders and work organization: advantages and limitations of workplace RCTs vs. other study designs for research-to-practice.....	158
<i>Early prevention, work organisation and participative approaches.....</i>	<i>159</i>
Ergonomic intervention research for MSD prevention: blending of two action frameworks towards a common goal .....	160
The effectiveness of participatory ergonomics to reduce psychosocial and physical risk factors for low back pain and neck pain; results of a cluster randomised trial .....	161
WMSD prevention: assessment of an ergonomic intervention six years later .....	162
Which possibilities for sustainable prevention of WMSD within lean manufacturing production methods?.....	163
Encouraging the adoption of ergonomic innovations: examining the effect of knowledge transfer techniques on construction companies' decisions to adopt innovations to reduce the risk of musculoskeletal disorders (MSD) ...	164
<b>Open sessions .....</b>	<b>165</b>
<i>Biology and mechanisms .....</i>	<i>166</i>
Back muscle injury: a cumulative trauma pathway.....	166
Conservative secondary interventions are effective at attenuating peripheral nerve inflammation and conduction velocity declines but not sensorimotor declines with high repetition high force task .....	167
Neck pain and postural stability among workers with high postural demands.....	168
Muscle recovery time from a single exhaustive work bout in the heat.....	169
Stress biomarkers' associations to pain in the neck, shoulder and back in healthy media workers. 12-month prospective follow-up.....	170
<i>Biomechanics.....</i>	<i>171</i>
A stochastic 3D static hand force prediction model for estimating maximum feasible hand forces during unilateral exertions.....	171
Combined hand-arm and whole-body vibration exposure - the effect on muscular activity in the trapezius.....	173
Relationships between forearm and trapezius muscle activity during key tapping .....	174
Comparison of time and level based EMG parameters for assessments of muscle activity patterns.....	175
Comparing power tool fastening and unfastening operations: exposures and physiological response .....	176
Sustained trapezius muscle activity and development of neck pain in young workers.....	177
Evaluating bicycle design using SEMG to study muscle fatigue .....	178
Upper-extremity muscle activity during flowers cutting and packing in a Colombian working population .....	179
EMG-ANT – A software package for analysis and comparison of surface electromyography data in occupational medicine.....	180
Change of electrogoniometric and torsionometric sensors accuracy with usage. ....	181
Protocol for evaluating trunk movement during lifting tasks performed in real work situation.....	182
Effect of backpack weight on postural angles in Thai school children.....	184
Are experienced workers more stable when handling loads? .....	185
Experienced manual materials handlers are more efficient to reduce lumbar spine loading .....	186
Can we identify workers at risk of developing knee OA using gait kinematic parameters? .....	187
Comprehensive analysis of the painful trapezius muscle using a proteomic method.....	188
Upper limb musculoskeletal disorder prevention: an application to wheelchair prescription and configuration.....	189
Changes in sitting posture during computer work .....	190
Effect of ergonomic school furniture properties on the sitting posture of child.....	191
Evaluation of muscle activity, forces, stresses, and moments at the knee during kneeling and squatting tasks .....	192
Effect of four different gloves on maximal grip force of sugar cane cutters .....	193
Development of low frequency fatigue in low-load repetitive wrist movements investigated with a servo-controlled motor system.....	194



Small influence of chronic pain and no influence of mood on vibrotactile perception thresholds among working women.....	195
Evaluation of wrist, forearm and elbow range of motion during box handling at a regular and an ergonomically designed support.....	196
Electrical assisted bicycle for postmen: consequences on physiological responses and cognitive performances..	197
Normalization techniques used in electromyographic evaluations of ergonomic interventions .....	198
Effect of lifting condition on the box trajectory variability .....	199
<b>Exposure measurement methods .....</b>	<b>200</b>
Long periods with sustained trapezius muscle activity and neck pain.....	200
Relations between work strain recording methods and clinical outcomes of WRULMSDs.....	201
Designing a methodology of capturing and assessing work-related risk factors for the carpal tunnel syndrome (CTS) .....	202
Variability of observed upper extremity physical exposures among different job types.....	203
Operational validity of CAPTMS design tool for assessing musculoskeletal disorder risk.....	204
A risk index focusing the time pattern of work and recovery .....	205
Cost-efficiency of adding another subject or another day to an exposure data set .....	206
The effect of sampling strategy on the accuracy and precision of variance component estimates .....	207
An index of physical workload to evaluate an ergonomics program in nursing homes.....	208
A comparison between worksite walkthrough assessments and self-reported musculoskeletal exposure and symptoms.....	209
Reliability of job-title physical work exposures for the upper extremity: comparison to self-reported and observed exposure estimates .....	210
The accuracy of self-report in determining computer use duration.....	211
OREGE, a relevant analysis tool for evaluating biomechanical stresses in various work situations .....	212
Validation of a general injury prediction algorithm.....	213
An approach to combining predetermined time analysis with ergonomic evaluation at assembly line design stage.....	214
Work related shoulder loads: establishment of a job exposure matrix.....	215
To increase the awareness of primary care physicians regarding the occupational part of some diseases. The example of MSD to improve their professional practices.....	216
Associating biomechanics and auto-confrontation for a better understanding of the movement made.....	217
Evaluation of ergonomic postures of assembling unit workers by rapid upper limb assessment (RULA).....	218
Integrated assessment of physical stress (IAD-BKB).....	219
Ergonomics hazards evaluation of the visual inspection process in the light emitting diode industry.....	220
Development of a workstyle observation protocol - a part of an instrument for assessment of cash-register work (BASIK) .....	221
Development of a workstyle questionnaire - a part of an instrument for assessment of cash-register work (BASIK) .....	222
Validation of the german key indicator method "manual operations" regarding identification of musculoskeletal health risks .....	223
MSD risk factors in rodworking: a task based analysis.....	224
The feasibility of using video tracking for studying arm movements in cash-register work, a pilot field study .....	225
Exposure assessment of musculoskeletal disorder risk factors in non-routinized work: a newly revised path tool .....	226
Risk assessment of upper limb work-related musculoskeletal disorders (UL-WMSDs) in repetitive tasks by OCRA method .....	227
Risk evaluation of developing distal upper extremity disorders by strain index method in an assembling electronic industry.....	228
Prevention of MSDs: self-perception in time and space with digital simulation of work.....	229
Occupational repetitive actions index (OCRA) application for a job rotation plan.....	230
WRULMSDs risk factors identification: risk assessment contributes in an automotive plant .....	231
<b>Physical exposure .....</b>	<b>232</b>
The personal load assistive device (PLAD) works: a review of current findings.....	232
Manual materials handling: expert handlers use different lifting strategies than novices .....	233
Physical workload on neck, shoulder and upper arm in various types of work.....	234
Assessment of performance and physical demands when using a prototype courier delivery truck .....	235
Effect of lifting condition on the anticipatory muscle recruitment prior to lifting.....	236
The impact of muscular and cardiovascular changes on the development of self-reported physical discomfort during a simulated standing work task .....	237
Comparing whole body vibration exposures between a cab-over and conventional truck.....	238
The development of a stage-I risk fil for physical workload .....	239
Pushing and pulling: a review of different work situations .....	240
Body weight influences lifting performance .....	241
Supports against static work in bending position – an EMG-study.....	242
Determinants of variation in gross physical activity during customer contact centre work.....	243



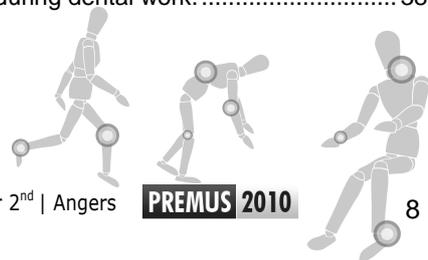
Evaluation of pushing and pulling at the workplace using a web-based push-pull-calculator.....	244
The effects of the upper limbs' pulling and pushing work in standing posture within the maximum work area on plantar pressure distribution.....	245
Assessment by experimented trainers of a tool designed to characterize manual material handling situations.....	246
Physical activity and cardiovascular regulation during clinical work in female students with and without musculoskeletal pain. method study.....	247
The effects of posture and fatigue on lumbar motion and erector spinae muscle activation during high frequency lifting and lowering.....	248
A tool for the assessment of handling of loads - the hut-calculator.....	249
Physical workload, low back pain and neck-shoulder pain - a Swedish twin study.....	250
Ergonomics intervention using movement analysis system and 3D modeling techniques: a case from industrially developing country (IDC).....	251
Price versus precision: cost efficiency in trunk posture observation.....	252
Maximum isometric forces of the whole-body in not upright postures and hand-finger-forces for the assembly-specific force atlas.....	253
Influence of handling items on the main determinants of risk factors for MSD during cashing activity in mass market retailing.....	254
<b>Psychosocial factors</b> .....	<b>255</b>
Risk factors for onset of persistent back pain among Japanese workers; findings from a prospective study : the Japan epidemiological research of occupation-related back pain (JOB) study.....	255
Work experiences in the beginning of the professional career – analyses among nurses and physicians using the effort-reward model.....	256
Risk factors for musculoskeletal symptoms among call center reservation and health managed care operators in São Paulo, Brazil.....	257
Psychosocial work factors and shoulder pain in hotel room cleaners.....	258
Workplace social capital and work-related repetitive strain injury in Canada: a cross-sectional analysis.....	259
Exposure to workplace psychosocial factors and chronic low back pain in hospital workers.....	260
The role of psychosocial factors and sleep quality for work-related musculoskeletal pain in the subway workers by shift work.....	261
Interactions of biomechanics and psychosocial stressors in relation to the development of MSDs in the modern office: the 'proof' study protocol.....	262
Role of psychosocial factors in musculoskeletal disorders in the tunisian textile industry workers.....	263
Is emotional demands a risk factor for musculoskeletal complaints among health care workers?.....	264
The predictive effect of fear-avoidance beliefs on low back pain among newly qualified health care workers with and without previous low back pain: a prospective cohort study.....	265
Which job constraints are linked to 'trouble in work' among employees suffering from back pain?.....	266
Sense of coherence, health behaviors, family stress and back pain among students.....	267
The associations between work and family psychosocial factors and musculoskeletal pain among nurses.....	268
Application of a comprehensive model (MODSI) for the risk assessment of musculoskeletal disorders.....	269
Does the work style contribute to musculoskeletal symptoms in Indian computer professionals?.....	270
<b>Computer work</b> .....	<b>271</b>
Redesigning the keyboard spacebar can improve wrist posture while typing.....	271
Differences in muscle load between computer and non-computer work among office workers.....	272
Postures and typing strategies in mobile device usage as characterized through an observational instrument.....	273
Keystroke duration shortens over the day during intensive computer use: a potential measure of keyboard related fatigue.....	274
The influence of perceived work demands on trapezius activity among emergency call-centre workers.....	275
Differential effects of physical and mental tasks on cervical muscle activity and cardiovascular responses.....	276
Computer work and musculoskeletal disorders of the neck and upper extremity: a systematic review.....	277
Perceived muscular tension is a risk factor for future neck-shoulder symptoms.....	278
A comparison of exposure assessment methods in computer workers.....	279
Concurrent validity of the symptom questions of the internet-based RSI Quicksan in computer workers.....	280
Accounting for individual variability improves estimates of biomechanical parameters in computer workers.....	281
Effect of sampling strategies on variance in exposure intensity metrics of typing force and wrist postural dynamics during computer work.....	282
Effects of workstation configuration on typing force, wrist postures and wrist dynamics.....	283
Differences in wrist postural dynamics across office workers during computer and non-computer tasks.....	284
Associations between discomfort and discrepancies in anthropometrics and workstation setup.....	285
Time distribution of transverse metacarpal arch during computer keyboard typing.....	286
Can accelerometer measurements of the head differentiate between two visually similar computer work tasks? ..	287
A video-based postural assessment system to measure rotation of the shoulder during computer use.....	288
A comparison of wrist ROM and the prevalence of wrist abnormalities identified with MRI between symptomatic and asymptomatic computer users.....	289



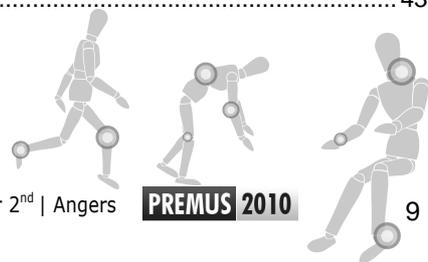
A survey of computer usage and ergonomic practices among faculty at a university with a mandatory mobile PC program.....	290
Place of musculoskeletal disorders in laptop use and their prevention with stretch break exercises.....	291
Musculoskeletal symptoms in children using computers at home - a proposed model.....	292
Musculoskeletal and visual discomfort among middle school notebook computer users.....	293
Health and performance benefits for children when using child-proportional mice and keyboards.....	294
Change of interkeypress intervals during 90-minute chinese typing with two input methods.....	295
Using EMG to evaluate ergonomic problems among the hand of mouse operators.....	296
A pilot for a randomized controlled trial into the effectiveness of an alternative mouse on pain/discomfort, results on feasibility and effectiveness.....	297
Guidelines to prevent computer-related musculoskeletal disorders in children.....	298
Adolescent spinal pain: a key target for multidisciplinary prevention of musculoskeletal disorders.....	299
Perceived effort whilst using mobile computing devices of different types.....	300
Muscle rest patterns in the upper trapezius and neck extensor muscles during two computer-based tasks in experimental and idiopathic neck pain.....	301
<b>Health care sector.....</b>	<b>302</b>
Ergonomic exposures to back disorder risk factors among healthcare workers: a description and comparison of hospitals and nursing homes.....	302
Work-related musculoskeletal disorders and prevention among home healthcare workers.....	303
Work-related musculoskeletal disorders in female Swedish physical therapists with more than 15 years of job experience: prevalence and associations with work exposures.....	304
The cultures of caring among healthcare professions and worker safety in acute care patient handling.....	305
Paramedics on the job: a biomechanical and physiological workplace analysis.....	306
Process variations, ergonomic stresses and quality.....	307
Lumbar-load quantification and overload-risk prevention for healthcare workers during patient-handling activities.....	308
The occurrence of musculoskeletal symptoms in South African nurses.....	309
Ergonomic devices reduce physical load during patient handling activities in nursing homes.....	310
Use of a lift assist team in an acute care hospital setting: prevention or transfer of risk of patient-handling injury?.....	311
The evaluation of a tool to measure the success of patient handling interventions; using field trials across the EU.....	312
A study of surgeons' postures and muscle activity during open, laparoscopic and endovascular surgery.....	313
Evaluation of the body gestures and posture constraints among medical care staff.....	314
Strategies used by paramedics to protect their back; the focus on preventive competences involved in prehospital emergency interventions.....	315
The musculoskeletal and mental disorders in Brazilian nursing workers: proposal for action.....	316
Ergonomic study of musculo-skeletal disorders in Monastir hospital (Tunisia).....	317
Validation and adaptation of a questionnaire to identify musculoskeletal symptoms linked to work.....	318
Changes in ergonomic exposures of nursing assistants following a no-lift program in nursing homes.....	319
Predictors for effective prevention of low back pain in nurses.....	320
Using a work systems analysis to redesign computer task exposures in radiologists.....	321
Work demands, constraints and musculoskeletal impacts among dishing cleaning workers of a cardiologic hospital in São Paulo, Brazil.....	322
Fatigue induced loading on the lumbar spine: an investigation of intra-shift variation in manual handling performance amongst physiotherapists.....	323
Musculoskeletal injuries among hospital patient care staff before and after implementation of patient lift and transfer equipment.....	324
Validity and reliability of the "job factors questionnaire" for physical therapist tasks.....	325
Development of an observational walkthrough checklist used to evaluate hospital worker safety within a patient care unit.....	326
<b>Musculoskeletal disorders in specific sectors.....</b>	<b>327</b>
Physical workload in different work tasks in female grocery store workers.....	327
Full-shift upper extremity direct exposure assessment among US dairy parlor workers.....	328
Compression and shear forces of the lower back in cabin attendants during pushing and pulling of meal carts.....	329
Health risks of african and latin drumming: instrument specific injuries of the upper extremities in hand drum players.....	330
Musculoskeletal symptoms and the effect of working in a cold environment among male construction workers.....	331
Follow up of the evolution of seasonal workers' pain and musculoskeletal symptoms: relevance of mixed methods approach.....	332
Chronic pain and employee experience as a starting point for ergonomic evaluations.....	333
Life style, work environment factors and musculoskeletal disorders in carpet handling occupation.....	334
Playing-related musculoskeletal disorders and stress-related health among percussionists.....	335
Prevalence of musculoskeletal symptoms among call center operators in São Paulo, Brazil.....	336
Prevalence of muscular-skeletal disorders among manual material handling workers in dairy product industry.....	337



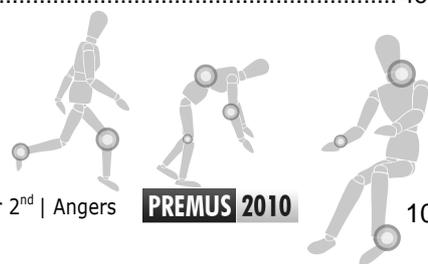
Determining the degree of disability in workers with upper limb musculoskeletal disorders using DASH .....	338
Work-related musculoskeletal disorders among Taiwanese flight attendants .....	339
Risk of cervical and lumbar intervertebral disc herniation (HIVD) among male bus drivers .....	340
Determination of working conditions, musculoskeletal complaints and muscular activity during office work.....	341
Work related factors of back pain among garment factory workers in Indonesia .....	342
Musculoskeletal symptoms and risk factors for musculoskeletal disorders among call center operators in Brazil ..	343
Prevalence of musculoskeletal disorders and physical risk factors among metal workers .....	344
Musculoskeletal complaints among classical musicians in Denmark .....	345
WRMD: a comparison between office and production personnel.....	346
Musculoskeletal disorders among women farmers: a comparison of traditional and improved tools.....	347
Musculoskeletal alterations and complaints among guitar and piano students. ....	348
Prevalence of musculoskeletal disorders among female office workers from a medical university .....	349
Risk factors for plantar fasciitis among assembly plant workers .....	350
<b>Epidemiology of the neck and upper limb .....</b>	<b>351</b>
Measured agreement between different research case definitions for carpal tunnel syndrome .....	351
Determining the level of evidence associated with risk factors for carpal tunnel syndrome: a systematic review ...	352
Predictors of carpal tunnel syndrome (CTS) among newly hired workers .....	353
Prevalence of carpal tunnel syndrome and abnormal median nerve conduction at time of hire .....	354
The associations of cardiovascular risk factors, carotid intima-media thickness and manifest atherosclerotic vascular disease with carpal tunnel syndrome .....	355
High heritability for concurrent low back and neck-shoulder pain – a study of twins .....	356
Improving the classification of upper limb disorders.....	357
Classifying non-specific upper extremity musculoskeletal disorders by cluster analysis: coming to a solution? .....	358
Epicondylitis related to work exposures of force, repetition, and posture .....	359
Ulnar neuropathy-like symptoms with negative electroneurography in relation to mechanical exposures assessed by a job exposure matrix: case-referent study .....	360
Ulnar neuropathy in relation to mechanical exposures assessed by a job exposure matrix: case-referent study ...	361
Work-related lesions of the supraspinatus tendon – a case-control study.....	362
Mechanical determinants of carpal tunnel syndrome in a population of the Colombian flower industry .....	363
Musculoskeletal symptoms among mobile hand held device users and their relationship to device use: a preliminary study in a Canadian university population .....	365
Has manual repetitive work an acute effect on median and ulnar nerve conduction parameters?.....	366
Associations between 3-month prevalence of neck pain and risk factors among undergraduate students .....	367
An experimental pain model for lateral epicondylalgia to assess its sensory-motor aspects.....	368
Performance of simplified scoring systems for hand diagrams in carpal tunnel syndrome screening .....	369
<b>Lower limb disorders .....</b>	<b>370</b>
Standing, kneeling and squatting at work associated with musculoskeletal disorders: meta-analyses. ....	370
Correlation between different physical exposures and patterns of cartilage damage in the knee .....	371
Validity of self-assessed reports and measuring data on work-related knee straining activities – results of a cross sectional study .....	372
Work participation, work adaptations, sick leave and self-reported health status in early osteoarthritis. a 2-year follow-up study in the cohort hip and cohort knee (check-study).....	373
Predictors for knee osteoarthritis - results of the case control study "ARGON".....	374
Occupational physical activity and meniscal tears: a review of the epidemiological literature.....	375
<b>Prevention: education, training, lifestyle .....</b>	<b>376</b>
Physical activity, diet and cognitive behavioral training as a combined worksite-based lifestyle intervention to reduce weight and musculoskeletal disorders in health care workers.....	376
Effects of health check based work site physical exercise. intervention among employees with physically heavy work. a randomized controlled study. ....	377
Effect of specific strength training on neck/shoulder pain: a randomized controlled trial among industrial workers	378
Evaluation of a Canadian mass media campaign aimed at preventing disability from back pain.....	379
Dynamic training on the lumbar musculature to prevent recurrence of acute low back pain: a randomized control trial using a daily pain recall for one year .....	380
A multidisciplinary prevention of work-related musculo-skeletal disorders of gravediggers: confrontation with biomechanical analyses using the methodology of the clinic of activity theory.....	381
<b>Prevention in various sectors .....</b>	<b>382</b>
Subgroup analysis of a randomized comparative trial on ergonomics in kitchen work.....	382
Applying ergonomics and biomechanics to reduce injuries and increase productivity in a commercial lighting manufacturing facility: a case study.....	383
Effect of workplace interventions on upper extremity MSDs: a systematic review .....	384
Enhancing musculoskeletal health and performance through training combined with a sit-stand workstation .....	385
Effects of prismatic glasses, on postures, perceived exertion and comfort, during dental work. ....	386



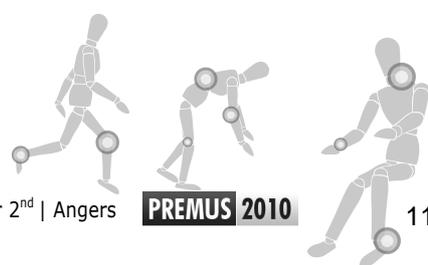
Painfulness at the workstation and prevention of exposure to MSD risk factors in a car manufacturer .....	387
Using Nordic style questionnaire in a multidisciplinary and participative approach for prevention of musculoskeletal disorders, a sustainable occupational prevention tool? .....	388
Musculoskeletal symptoms and job-related factors among workers from an industrial sector .....	389
Adjustable carts: an effective intervention for reducing the low back injury risk for grocery stockers .....	390
Does statistically significant reduction in pain lead to relevant improvements in functional outcomes after workplace exercise for controlling pain? A systematic review .....	391
Reducing musculoskeletal disorders among dentist operators: an ergonomic intervention approach to improve working conditions.....	392
Strategies for prevention of MSD in a large French occupational health department.....	393
Ergodistrib: a national, multidisciplinary study for the prevention of musculoskeletal disorders of the upper limbs and spine in partnership with management representatives of the main French food distributors .....	394
The effect of a shoulder pad on shoulder complaints and productivity in scaffolders .....	395
The development of "MUSKA" as tool to support a long lasting MSD prevention in the worplace .....	396
Hand tool design and ergonomics: design of a new hammer for slaters .....	397
A macro-ergonomic approach to injury prevention .....	398
Effective dissemination of an ergonomically-modified blueberry rake .....	399
Intervention against work-related musculoskeletal disorders (WRMD) among office workers from public sector ...	400
Load carriage: minimising soldier injuries through physical conditioning – a narrative review .....	401
Biomechanical metrology: a support in occupational controversies .....	402
Surveillance for mitigation of occupational health hazards and musculoskeletal problems of agricultural workers through educational intervention .....	403
<b>Measuring effects of interventions .....</b>	<b>404</b>
Explicit and implicit change theories behind ergonomic interventions in working life; a systematic review .....	404
Methods to evaluate the effectiveness of physical activity promotion measures at sedentary workplaces .....	405
A randomized controlled trial of a tailored musculoskeletal disorder prevention intervention – preliminary results.	406
Workplace interventions for neck pain in workers. a systematic review .....	407
Participatory ergonomics: evidence on effectiveness and implementation.....	408
<b>Economic aspects .....</b>	<b>409</b>
Workplace ergonomic interventions with economic analyses: a systematic review .....	409
Economic evaluations of occupational health interventions from a company's perspective: a systematic review of methods to estimate the cost of health-related productivity loss .....	410
Economic evaluation of an intervention program on exposure to risk factors, prevalence of arm, shoulder and neck symptoms, and sick leave in computer workers .....	411
Direct workers' compensation costs for patient handling injuries surrounding a hospital-wide policy change to minimal manual lifting of patients .....	412
An economic justification for the implementation of interventions that reduce knee injuries in underground mining	413
Musculoskeletal disorders compensation costs as a function of age and industry.....	414
<b>Work ability, physical fitness .....</b>	<b>415</b>
What explains return to work and work ability- an analysis of expectations, health and disability variables.....	415
Relevance of normative values for Functional Capacity Evaluation .....	416
Predictive validity of self-reported work ability and functional capacity evaluation lifting tests on durable return to work in construction workers .....	417
Testing physical work ability of Dutch fire fighters in a job-specific way .....	418
Physical fitness of korean workers by age, gender, and job character.....	419
The profile fitness mapping questionnaire for the neck - reliability and validity of a new questionnaire for symptoms and functional limitations in subjects with neck pain .....	420
Use of job-specific functional capacity evaluation to predict the employment status of patients with nonspecific low back pain.....	421
Working despite chronic nonspecific musculoskeletal pain: a qualitative study .....	422
The work role functioning questionnaire and chronic musculoskeletal disorders: has it a clinical study (results from a prospective study of 539 workers)?.....	423
Work ability among senior workers (50+) in a construction company.....	424
Elderly workers in physically demanding jobs: how do they manage? .....	425
Strength and lumbar range of motion related to low back pain (LBP) and age .....	426
Does functional capacity decline in healthy ageing workers?.....	427
Working despite chronic nonspecific musculoskeletal pain: a qualitative study .....	428
Professional based classification versus self reported measures as a basis for choice of intervention - patients with musculoskeletal and mental disorders .....	429
<b>Prognosis and recurrence .....</b>	<b>430</b>
Psychosocial risk factors for transition from acute to chronic low back pain in primary health care. review of the literature .....	430

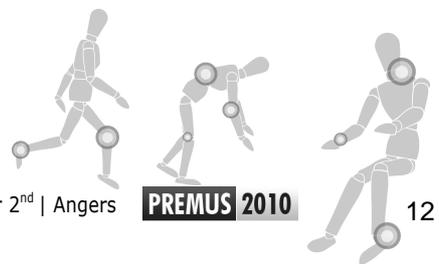


Risk factors for reduced productivity among young adults with musculoskeletal symptoms in neck or upper extremity – a prospective cohort study .....	431
Pressure pain thresholds at different body regions in chronic musculo-skeletal disorders (MSD) vs healthy .....	432
Occupational outcome in 2007-2008 of workers suffering from musculoskeletal disorders in the French Pays de la Loire region .....	433
Recurrence of low back pain: injured workers' perspectives .....	434
The "Vibrosense®": screening and follow-up of neurological damage by hand-arm vibrations.....	435
Psychometric evaluation of the questionnaire "the pain disability questionnaire - PDQ" – Brazilian Portuguese version.....	436
Open versus endoscopic carpal tunnel release: using quickdash (a shortened disabilities of the arm-shoulder-hand questionnaire) in Bouches-du-Rhône, France, April 2008 to December 2009 (preliminary results) .....	437
Permanence of musculoskeletal disorders at construction workers – a follow-up .....	438
Lumbar bone mass predicts low back pain in males .....	439
Pain attenuation and its relationship to function in a longitudinal low back pain cohort.....	440
High need for recovery and absences for musculoskeletal disorders .....	441
Profile of the Sao Francisco university employees accomplished physiotherapy service in occupational health and ergonomics.....	442
Sick leaves in the two years following intervention for low back pain: a randomized controlled study comparing multidisciplinary functional restoration and ambulatory physiotherapy .....	443
Effectiveness of a new sequenced multi-disciplinary rehabilitation protocol for thoracic outlet syndrome in Indian computer professionals .....	444
Predicting injured workers' experience of "absenteeism ↔ at-work productivity loss" over one year after WSIB specialty clinic attendance.....	445
"Work instability" predicts greater work disability and downward transitions in work status for injured workers with upper-limb disorders after one-year attendance at a WSIB specialty clinic.....	446
Can internationally recommended outcome domains capture aspects that are prominent for the health experiences of women with neck- and shoulder pain? - a factor analysis. ....	447
<i>Return to work / Tertiary prevention.....</i>	<i>448</i>
Developing a guide for measuring the concept of margin of manoeuvre .....	448
Early intervention with low back injured workers in the workers' compensation context .....	449
Comparative study on the use of kinesiotherapy in groups and individually on patients with work-related musculoskeletal disorders (WRMSD).....	450
Effects of a multidisciplinary intervention program in back and neck pain patients absent from work- baseline data and effects on subjective workability, lifting capacity and sickness absence over 12 months.....	451
Physical conditioning programs for improving work outcomes in workers with back pain: A Cochrane Systematic Review .....	452
Determinants for staying at work in people with chronic nonspecific musculoskeletal pain: a systematic review. ...	453
Factors at work acting as buffers against neck/shoulder and low back disorders .....	454
Rehabilitation is seldom prescribed at the initiation of a new sick-leave period - a study on sickness certificates in Sweden .....	455
The impact of health system coverage and benefit design on work incentives and disability prevention.....	456
Implementing return to work interventions for workers with low back pain: a conceptual frame to identify barriers and facilitators .....	457
Effectiveness of a global posture reeducation program for patients with low back pain.....	458
Rooms for manoeuvre and difficulties met by foremen and their role for a sustainable MSD prevention.....	459
Evaluation of a physiotherapy care with a multidisciplinary intervention including medical and ergonomic approach .....	460
The benefits of physical therapy training for low back pain at work.....	461
The management of sickness absence in the transport industry - a 10 year experience .....	462
Disputed chronic neurogenic thoracic outlet syndromes: results of a multidisciplinary approach of the return to work .....	463
The fear avoidance model relation ships with the readiness for return to work scale in different musculoskeletal disorders .....	464
Back to work after dorsal musculoskeletal disorders: the role of the company .....	465
Difficulties and obstacles in the return to work of workers affected by occupational diseases attended to in a reference center for the worker's health in Sao Paulo – Brazil.....	466
Contributions of group physical therapy sessions to the return to work of patients with work related musculoskeletal disorders (WRMD).....	467
Validation of the 11-item organizational policies & practices scale (OPPS) for injured workers recovering from work-related upper-limb disorders.....	468
<i>Musculoskeletal disorders at a population level.....</i>	<i>469</i>
Health beliefs and health worries: predictors of care-seeking with back pain or any musculoskeletal pain in a cohort of the general working population .....	469

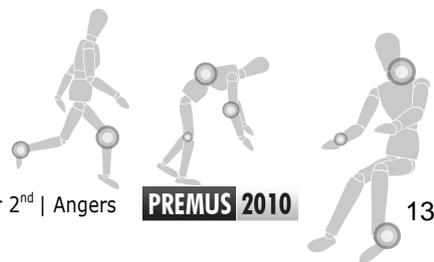


Incidence of shoulder lesion diagnoses in southern sweden – data from a population-based health care register.	470
Work-related predictors of medical care-seeking with neck and upper extremity pain and back pain in a cohort of the general working population .....	471
Assessment of work-related musculoskeletal disorders using quality of worklife data from the 2006 general social survey.....	472
Towards a consolidated measure of the physical, organisational and psychosocial risk factors for work-related musculoskeletal disorders.....	473
Finnish workers' opinions on continuing to work after the age of 63 and musculoskeletal disorders .....	474
Risk factors for rotator cuff syndrome and shoulder pain in the working population.....	475
Population attributable risk of lumbar disc surgery according to occupation: a study in a french general population .....	476
Economic sectors and occupations at risk for the development of lumbar spine diseases – results of the German spine study.....	477
Musculoskeletal disorders subjectively enhance the cooling induced decrease in mental and fine motor performance .....	478
Lifestyle and metabolic factors in relation to shoulder pain and rotator cuff tendinitis: a population-based study ...	479
<b>Gender differences.....</b>	<b>480</b>
Exposure-response relationships for work-related musculoskeletal disorders in elbows and hands.....	480
Gender differences in computer use, musculoskeletal symptoms and perceived stress among young adult students .....	481
Sex differences in neck and shoulder strength, muscle activity and responses to fatigue and pain: possible links with WMSD? .....	482
Gender differences in occupational disc-related diseases of the lumbar spine caused by lifting, carrying or extreme trunk flexion in Germany .....	483
Serious pain related to static work is twice as frequent in female dentists as in male dentist .....	484
Gender involvement in manual material handling (MMH) tasks in agriculture and resulting musculoskeletal disorders.....	485
Work in forward bent position in assistant nurses .....	486
A study of gender-based work organization among sanitation and maintenance employees at a Québec hospital	487
The relationship between physical fitness, physical work intensity, and work ability index (WAI) .....	488
Women's perception of risk from occupational musculoskeletal exposures .....	489
Gender in expectations before visits to primary care for neck and back patients.....	490
Gender differences in size and structure of variability .....	491
The effect of cognition improvement program on work ability .....	492
<b>Surveillance and prevention policies.....</b>	<b>493</b>
Health and socioeconomic impact study of European initiatives on the prevention of work-related MSDs in Europe .....	493
WMSD Surveillance using workers compensation (WC) data.....	494
Strategies for MSD prevention – a new model proposed by a Belgian task force.....	495
Epidemiology of upper limb musculoskeletal disorders and work disability in 2.300.980 insurants of the statutory health insurances in Germany.....	496
Ergonomic factors of traumatic low back pain approved in 2006-2008 workers' compensation claims.....	497
Underreporting of non-traumatic work-related musculoskeletal disorder work absences to workers' compensation: Results of a 2007-2008 population survey .....	498
A more objective evaluation of the repetitiveness in the compensation of musculoskeletal disorders: the case of Tunisia.....	499
Conditions for implementing a sustainable MSD prevention in the workplaces, a study cases of 30 French companies.....	500
Epidemiological surveillance of upper limb musculoskeletal disorders (ULMSDs) in occupational setting in a west region of Algeria .....	501
An assessment methodology for ergonomic chair quality and competency in the workplace .....	502
Standard to prevention of musculoskeletal disorders among call center operators in Brazil.....	503
Ergonomic risks and musculoskeletal disorders prevention.....	504
Low back pain and stratified management: a necessity .....	505
Determining work-relatedness of musculoskeletal injuries- plantar fasciitis as a case example. ....	506
<b>Index of authors.....</b>	<b>507</b>





# KEYNOTES





**Nicole Vézina** is an ergonomist and member of the *CINBIOSE* research center and the *Institut de santé et société* at the University of Quebec in Montréal. She is also the directing professor of the professional masters in ergonomics within the department of kinesiology. Her research includes projects aimed at the promotion of health at work, particularly the prevention of musculoskeletal disorders. She is interested in the development of the ergonomic process used in workplace interventions. Her research and intervention projects have led to participation with interdisciplinary teams and interest in work organization (job rotation), training at work (transferring know-how) and rehabilitation (concept of *marge de manoeuvre*).

## THE EVOLUTION OF OUR REPRESENTATIONS OF WMSD: INTEGRATING KNOWLEDGE AND ENSURING CONCERTED PREVENTIVE ACTION

VÉZINA N.

*CINBIOSE, Université du Québec à Montréal, Montréal, Canada*

Work-related musculoskeletal disorders (WMSD) constitute an important and complex health problem of multifactorial origin that poses a major challenge to our understanding and our capacity to intervene. A conference such as PREMUS provides an enriching opportunity to share knowledge among researchers from different disciplines engaged in the study of WMSD. We need to pull together and increase our knowledge about the phenomenon of WMSD and about interventions in order to better understand its various dimensions and to intervene effectively in prevention and return to work. In order to advance in this direction, it would certainly be useful to recognize and dismantle the multiple barriers that exist at different levels between our various fields of research, between the different institutions that address WMSD, and between services provided in workplaces themselves. Breaking down these barriers requires the evolution of our own representations and the sharing of concepts. In this presentation, we will focus on interventions to prevent WMSD as an object of research, as a source of knowledge and as a means of bringing together the various disciplines.

### Knowledge gained from interventions

The interest of researchers in the process of intervention in the workplace has expanded considerably since the pioneering work of Daniellou (1992) on ergonomic intervention. Cole et al (2005), in a review of the literature on the effectiveness of participatory ergonomic interventions, highlighted the significance of this type of intervention, but also the usefulness of describing the intervention process. In a second literature review by the Institute for Work and Health (IWH) aimed at better understanding the intervention process, Van Eerd et al (2008) saw the advantage of accessing the “gray” literature, that is, the literature published outside of formal scientific journals. In general, scientific journals put more emphasis on the presentation of results, preferably quantitative, and do not encourage adequate description of the nature and content of the intervention and the intervention process. St-Vincent et al (2010) have sought the French language gray literature (reports, seminars, theses, etc.) that provides more detailed descriptions of ergonomic interventions in order to better understand the strategies developed by practitioners. However, the vast majority of published interventions are carried out in the context of research projects and little is still known about the interventions carried out by frontline practitioners in various workplaces. Certain authors (Lamonde et al, 2000; Garrigou & Peissel-Cottenaz, 2004; Baril-Gingras et al, 2004; Caroly et al, 2008) were pioneers in terms of describing the interventions of practitioners in order to better understand the contextual factors influencing interventions, including the facilitators and barriers to the intervention process. Even rarer are published descriptions by practitioners themselves (Brunet, 2009) of the important work they do to develop awareness and mobilize workplaces so that they are open to and undertake preventive actions.

### Do we know the needs of front-line practitioners?

Front-line practitioners in prevention organisations are often the principal agents of change in workplaces. Their interventions to prevent WMSD can take many forms and are based on different approaches depending on the practitioner and/or the prevention agency he or she belongs to. The approaches can range from training to increase awareness of workplace parties about WMSD risk factors, giving advices about



changing furniture, taking various measures, using checklists to identify risk factors in order to prioritize jobs requiring ergonomic changes or it may be undertaking a quite elaborate ergonomic intervention process that takes into account both macro and micro aspects of work situations and involves a variety of workplace actors (Guerin et al., 2006, Wells et al., 2000), or it may be a mixture of different approaches. What are the needs of these practitioners? How can researchers contribute to their prevention efforts?

Various researchers have collaborated on the development of tools that are aimed at helping practitioners quickly identify WMSD risk factors within the workplace. The integration of knowledge from a variety of disciplines including biomechanics and epidemiology, have led to the development of holistic models (Sauter & Swanson, 1995; Stock et al, 2006) that demonstrate, among other things, that working conditions such as inadequate workstation layout or oppressive work organisation may lead, on the one hand, to musculoskeletal overloading and, on the other, to psychological distress of workers. Are these systemic perspectives really integrated into the tools proposed for use in the field? During interventions, practitioners are faced with the complexity of work situations and they would benefit from access to a much richer understanding of them (Bourgeois et al, 2006). Over and above the techniques inherent in the tools designed for practitioners, it would be useful to orient knowledge translation tool research on the principles underlying intervention practices.

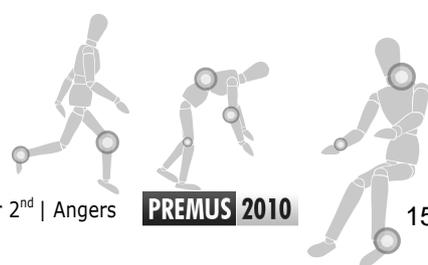
In addition, detailed follow up of interventions carried out by ergonomists in training has demonstrated that the main difficulties they encounter concern the development of strategies related to the social construction of the intervention (Vézina & Baril, 2009). Integrating WMSD prevention into companies requires the development of interaction with multiple workplace actors at different levels and in different departments of the organisation, as well as the establishment of a collaborative process between these actors which often must be initiated by the ergonomist because prevention in the workplace is often viewed as the sole responsibility of human resource managers. It is also necessary to develop other tools, for example, to evaluate the socio-organisational aspects of ergonomic intervention (Bellemare et al, 2008).

## Conclusion

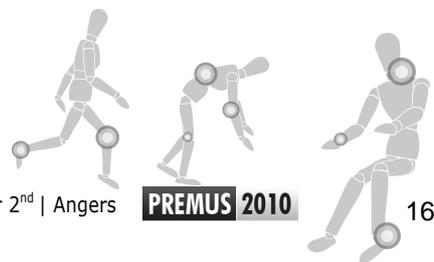
The advancement of research in each discipline remains very important to improve our conceptual models WMSD, but interdisciplinary research must be a priority because “the comprehension of phenomena that determine WMSD lies at the crossroads of the disciplines” (Aptel & Vézina, 2008). Increasingly, research granting agencies encourage interdisciplinary research; however, they rarely take into account the time and depth of learning required for each collaborator to understand the others’ points of view, or to make his or her point of view accessible to the other co-investigators. Moreover, the study of WMSD preventive interventions in the workplace conducted by practitioners in the field should be regarded as a source of invaluable knowledge that can help us better understand the phenomenon of WMSD, enhance our conceptual models, demonstrate the value of original practices and develop new field tools and methods that facilitate the preventive work of practitioners. The evaluation of these interventions must include a sharing of a broad range of points of view on different methodologic strategies (Coutarel et al, 2009). This presentation invites a reflection on the needed evolution of our research and our interventions to foster better and more concerted action to prevent WMSD in the workplace.

## References

- Aptel, M., Vézina, N. 2008. Quels modèles pour comprendre et prévenir les TMS? Pour une approche holistique et dynamique. *2e Congrès francophone sur les troubles musculo-squelettiques : de la recherche à l'action*, Groupe de recherche francophone sur les TMS, Montréal.
- Baril-Gingras, G., Bellemare, M., Brun, J.-P. (2004) Intervention externe en santé et en sécurité du travail : un modèle pour comprendre la production de transformations à partir de l'analyse d'interventions d'associations sectorielles paritaires. *Études et recherches / Rapport R-367*, Montréal, IRSST, 287 pages.
- Bellemare, M., Duval, L., Baril-Gingras, G., Ross, J. Poulin, P. (2008) Des outils pour analyser les aspects socio-organisationnels de l'intervention, *2e Congrès francophone sur les troubles musculo-squelettiques : de la recherche à l'action*, Groupe de recherche francophone sur les TMS, Montréal.
- Bourgeois, F., Lemarchand, C., Hubault, F., Brun, C., Polin, A., Fauchoux, J.M. (2006). *Troubles musculo-squelettiques et travail – Quand la santé interroge l'organisation*. 2<sup>e</sup> édition. Éditions de l'ANACT, Paris, 308 p.
- Brunet, R. (2009) Les pratiques des organismes en prévention des TMS : Terrain de recherche et chercheur de terrain. *Perspectives interdisciplinaires sur le travail et la santé* : 11(2). [www.pistes.ugam.ca](http://www.pistes.ugam.ca)
- Caroly S., Coutarel F., Escriva E., Roquelaure Y., Schweitzer J.M., et Daniellou F. (coord.) (2008). *La prévention durable des TMS : Quels freins? Quels leviers d'action?* Rapport d'étude pour la Direction générale du travail, disponible sur le site [www.anact.fr](http://www.anact.fr).
- Cole, D., Rivilis, I., Van Eerd, D., Cullen, K, Irvin, E., Kramer, D. 2005. *Effectiveness of Participatory Ergonomic Interventions: A Systematic Review*. Institute for Work & Health, Toronto, ON, Canada.
- Coutarel, F., Vézina, N., Berthelette, D., Aublet-Cuvelier, A., Descatha, A., Chassaing, K., Roquelaure, Y., Ha, C. (2009) Orientations pour l'évaluation des interventions visant la prévention des Troubles Musculo-Squelettiques liés au travail. *Perspectives Interdisciplinaires sur le Travail et la Santé*, 11(2).



- Daniellou, F. (1992) Le statut de la pratique et des connaissances dans l'intervention ergonomique de conception. Document de synthèse, Université de Toulouse-Le Mirail. 1992;100p.
- Garrigou, A., Peissel-Cottenaz, G. (2004) Contribution à la découverte du métier de préventeur et à la caractérisation de leurs besoins en formation continue. Note scientifique et technique NS 244. INRS (France).
- Guérin, F., Laville, A., Daniellou, F., Duraffourg, J., Kerguelen, A. (2006) Comprendre le travail pour le transformer (3e édition). ANACT, Lyon, 318 pages. English version : (2007) Understanding and transforming work. The practice of ergonomics. Lyon, ANACT, 282 pp.
- Lamonde F., (2000). L'intervention ergonomique. Un regard sur la pratique professionnelle. Toulouse, Octarès.
- Sauter, S.L., Swanson, N.G. (1996) An ecological model of musculoskeletal disorders in office workers. Dans: *Beyond Biomechanics: Psychosocial Aspects of Musculoskeletal Disorders in Office Workers*. Moon, SD., Sauter, SL. (ed), Taylor and Francis Publishers, London, England, pages 3-22.
- Stock S, Vézina N, Seifert AM, Tissot F, Messing K. (2006). Les troubles musculo-squelettiques au Québec, la détresse psychologique et les conditions de travail : relations complexes dans un monde du travail en mutation. *Santé, Société et Solidarité de l'Observatoire franco-québécois de la santé et de la solidarité*. Vol. 6 (2): 45-58.
- St-Vincent, M., Vézina, N., Laberge, M., Gonella, M., Lévesque, J., Petitjean-Roget, T., Coulombe, T., Beauvais, A., Dubé, J., Lévesque, S., Cole, D. (sous presse) L'intervention ergonomique participative pour prévenir les TMS : ce qu'en dit la littérature francophone. *Collection Études et Recherches – IRSST*.
- Van Eerd D, Cole D, Irvin E, Mahood Q, Keown K, Theberge N, Village J, St. Vincent M, Cullen K, Widdrington H. (2008) Process and implementation of participatory ergonomics interventions: A systematic review. Institute for Work & Health, Toronto, ON, Canada.
- Vézina, N., Baril, R. (2009) Apprendre à intervenir : difficultés rencontrées par de jeunes ergonomes et stratégies. *40e Congrès annuel de l'Association Canadienne d'Ergonomie* : Québec, Québec.
- Wells, R., Norman, R., Frazer, M., Laing, A. (2000) *Research at work. Ergonomics Program Implementation Blueprint*, University of Waterloo, 20 pages.





**Benjamin C. Amick III, Ph.D.**

Professor of Behavioral Sciences and Epidemiology

University of Texas School of Public Health

Scientific Director

Institute for Work & Health

Toronto, Canada

## **THE ECONOMICS OF WORK-RELATED MUSCULOSKELETAL DISORDERS: WHAT EXACTLY DO WE WANT?**

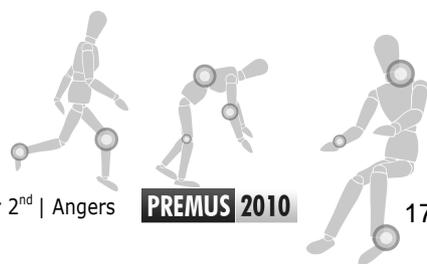
AMICK B.C.

*University of Texas School of Public Health, Texas, USA - Institute for Work & Health, Toronto, Canada*

As more and more research seeks to link health and productivity outcomes and as new tools emerge for assessing productivity, it is important for the research community to reflect on exactly what do we want? The presentation examines two distinct but inter-related literatures: the literature seeking to make the business case for investing in musculoskeletal disorder change and the literature assessing the impact of musculoskeletal disorders (MSDs) on an individual workers ability to work or health-related work performance.

While many MSD researchers seek to determine the cost-effectiveness or return-on-investment of an MSD intervention what evidence exists that interventions shown to be cost-effective are, in fact, adopted as best practices. Well designed and implemented intervention research with economic outcomes is resource intensive. It has remained a belief in the MSD community that this is a worthwhile investment. Evidence from a recent large field evaluation and systematic reviews will be used to illustrate key issues to consider when asking whether the research investment is worth the translational benefits to various stakeholders.

Lost productivity as measured by absence has been augmented recently by a new class of measures assessing lost productivity at work. Drawing on pharmacoeconomic research, MSD researchers believe that capturing the economic losses associated with MSDs when the worker is working will further increase the value proposition for specific interventions. Conceptually, the field is dominated by two types of measures: one that seeks to be integrative illustrated by the work ability index and one focused on role functioning illustrated by the work limitations questionnaire. Yet, little work has examined the conceptual and methodological robustness of the various approaches to capturing 'presenteeism'. Drawing on research based in the development of the work limitations questionnaire and the work role functioning questionnaire recommendations will be made for future translational research.





**Barbara Silverstein**  
SHARP, Washington State Dept of Labor & Industries

**WMSDs: KNOWLEDGE, PRACTICE, POLICY**

SILVERSTEIN B.

SHARP, Washington State Dept of Labor & Industries, USA

**Aims:**

To provide SHARP examples of how research influences workplace practices and public policies. Examples include

- 1) Washington State (WA)(TIRES) project,
- 2) WA Ergonomics Regulation,
- 3) WA SPH legislation,
- 4) impact of WA OSHA on WC claims rates.
- 5) Precarious employment requires more attention.

**Methods:**

We use state WC and OSHA data to prioritize prevention efforts. Seven types of injuries represent 90% of all WC state fund claims, lost workdays and costs (Figure 1).

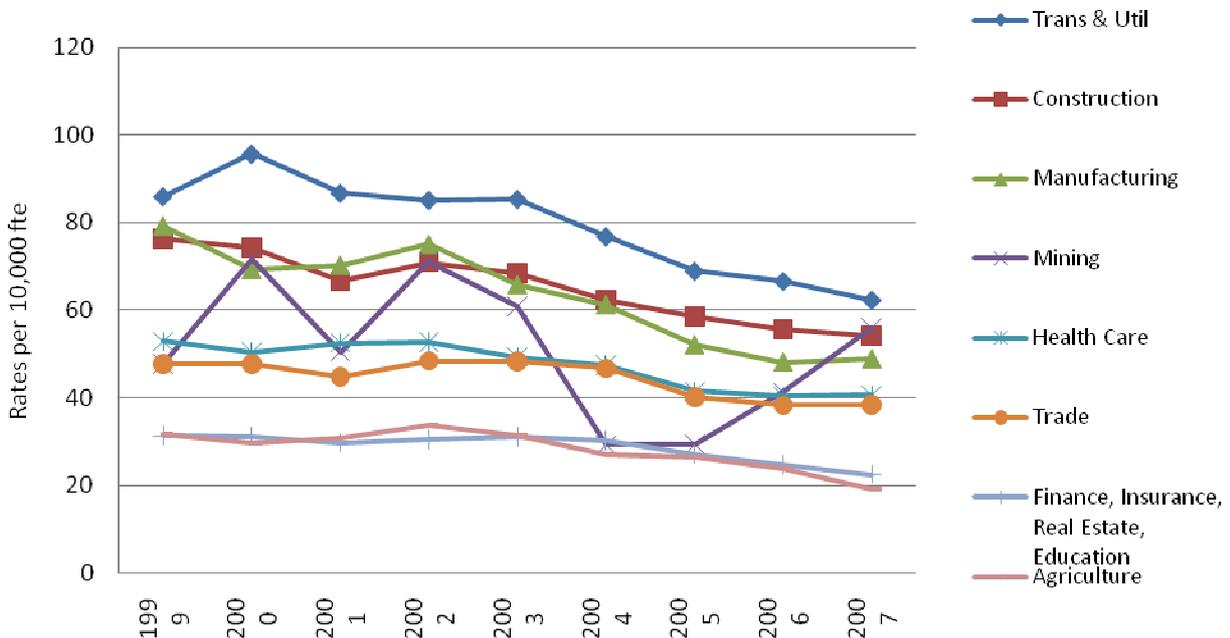
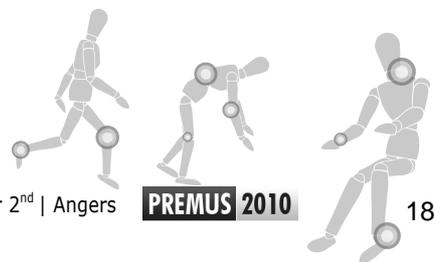


Figure 1. Washington State Fund Upper Extremity WMSDs Compensable WC Claims Rates by Industry Sector



We use a prevention index (PI) to prioritize activities, averaging incidence rate and count rank order. WMSDs are more than 50% of all claims, costs and time loss days. General and Specialty Freight trucking were in the top 5 industries by PI in all but falls from elevation.

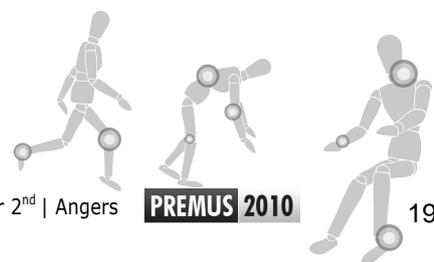
**Results:**

- 1) SHARP TIRES project (<http://www.keeptruckingsafe.org>) works with trucking companies to develop prevention strategies.
- 2) Ergonomics regulation. SHARP reports (1998) on
  - 1) magnitude and distribution of WMSDs by industry,
  - 2) results of a 5,000+ employers survey on workplace WMSD risk factors and ergonomics activities, were key for ergonomics rulemaking, enacted in 2002 and repealed in 2003. Subsequent decline in ergonomics activities cost \$180 million per year.
- 3) Safe Patient Handling (SPH). SHARP is evaluating implementation of Safe Patient Handling legislation [2006ESH1672] for acute care hospitals by comparing hospitals in Washington (legislation) and Idaho (no legislation) at 3 points in time (2007, 2009, and after full implementation (2011) of the SPH legislation. The 2009 assessment indicates Washington hospital staff have increased awareness of WMSD hazards and preventive measures, implemented SPH committees, equipment and training to a significantly greater degree than Idaho hospitals.
- 4) Consultation and Enforcement. SHARP assesses the impact of State OSHA enforcement and consultation activities on workers compensation claims injury rates by employer size and industry. In five of the last 8 years, statistically significant reductions in WC claims rates were seen with enforcement but not consultation in fixed worksites. Closer examination of targeting strategies is underway. The fact that there are no WMSD regulations to enforce may have some impact on these findings and future strategies.
- 5) Precarious Employment. The contingent workforce is growing. These workers tend to be the most vulnerable with the least protection. We need to better understand the magnitude of the risk of WMSDs and ways to address them in this population. This will require research, practice, regulation, and evaluation.

**Keywords:** Surveillance, Public policy

**References:**

- Foley M, Silverstein B, Pollisar NL, Neradilek, B (2008). Impact of implementing the Washington state ergonomics rule on employer reported risk factors and hazard reduction activity. *AJIM* 52(1):1-16.  
Washington State Legislation 2006-ESH1672  
Smith C, Silverstein B, Bonauto D, Fan J (2009). Temporary workers in Washington State 2009 *AJIM* 2009 Jul 17. [Epub ahead of print.



**Gisela Sjøgaard**

*Institute of Sport Science and Clinical Biomechanics, University of Southern Denmark.  
Odense, Denmark*

**MECHANISMS IN MUSCLE ACTIVITY: CONTRASTING EFFECTS ON HEALTH**

SJØGAARD G.

*Institute of Sport Science and Clinical Biomechanics, University of Southern Denmark. Odense, Denmark*

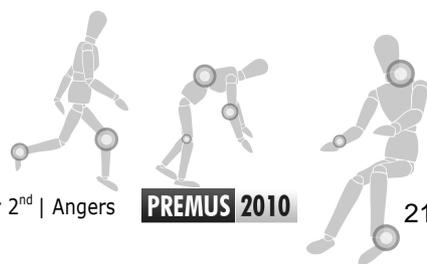
Muscle activity is a corner stone in physical activity that promotes health, and occupational physical activity in line with leisure-time physical activity is considered to provide health benefits (7; 10; 11). Accordingly, the international recommendations for health-promoting physical activity do not distinguish between occupational and leisure time physical activity (Physical activity guidelines advisory committee 2008). However, in this context attention has not been paid to the extensive literature documenting occupational physical activity to impair health - and in particular musculoskeletal health. Physical activity at work is generally quantified in terms of biomechanical exposure assessment (19) and most often focuses on risk factors for musculoskeletal health such as heavy lifting, bending, twisting, awkward postures, and monotonous repetitive work (8; 9; 12; 14). Relations between such exposures and impaired musculoskeletal health is unequivocal (8; 16). In contrast, when quantifying leisure-time physical activity focus is on dynamic activity performed with large muscle groups that increases metabolic and cardiovascular load (13) and such activities are often tautologically termed HEPA, health enhancing physical activity (17). This clearly demonstrates the contrasting effects of muscle activity and these contrasting effects depend not only on mode of muscle activity but also on the intensity, duration and repetition of the activity (18). Training studies in sports science have documented improved muscle performance as well as health, and delicately described the training programs for success together with the biochemical and molecular mechanisms in the muscle tissue. Occupational exposure, however, has been demonstrated to result in muscle pain and objective signs of impaired muscle function, metabolism and morphology with e.g. extensive monotonous repetitive work such as office and computer work (3; 4; 15). Intelligent physical exercise training – based on sports science principles – was recently introduced at the work site in terms of all-round physical activities, strength training or bicycling, and demonstrated to alleviate pain, improve muscle metabolism as well as function (1; 2; 5). This knowledge is presently being implemented at additional diverse occupational settings introducing physical exercise training at the work site tailored to the job profile and the capacity of the workers (6).

**References**

1. Andersen LL, Andersen JL, Suetta C, Kjaer M, Sogaard K and Sjøgaard G. Effect of contrasting physical exercise interventions on rapid force capacity of chronically painful muscles. *J Appl Physiol* 107: 1413-1419, 2009.
2. Andersen LL, Kjaer M, Sjøgaard K, Hansen L, Kryger A and Sjøgaard G. Effect of two contrasting types of physical exercises on chronic neck muscle pain. *Arthritis Rheum* 59: 84-91, 2008.
3. Andersen LL, Nielsen PK, Sjøgaard K, Andersen CH, Skotte J and Sjøgaard G. Torque-EMG-velocity relationship in females workers with neck muscle pain. *J Biomech* 41: 2029-2035, 2008.
4. Andersen LL, Suetta C, Andersen JL, Kjær M and Sjøgaard G. Increased proportion of megafibres in chronically painful muscles. *Pain* 139: 588-593, 2008.
5. Blangsted AK, Sjøgaard K, Hansen EA, Hannerz H and Sjøgaard G. One-year randomized controlled trial with different physical-activity programs to reduce musculoskeletal symptoms in the neck and shoulders among office workers. *Scand J Work Environ Health* 34: 55-65, 2008.
6. Holtermann A, Jørgensen MB, Gram B, Christensen JR, Faber A, Overgaard K, Ektor-Andersen J, Mortensen OS, Sjøgaard G and Sogaard K. Worksite interventions for preventing physical deterioration among employees in job-groups with high physical work demands: background, design and conceptual model of FINALE. *BMC Public Health* 10: 120, 2010.
7. Hu G, Tuomilehto J, Borodulin K and Jousilahti P. The joint associations of occupational, commuting, and leisure-time physical activity, and the Framingham risk score on the 10-year risk of coronary heart disease. *Eur Heart J* 28: 492-498, 2007.
8. Lund T, Labriola M, Christensen KB, Bultmann U and Villadsen E. Physical work environment risk factors for long term sickness absence: prospective findings among a cohort of 5357 employees in Denmark. *BMJ* 332: 449-452, 2006.



9. Marras WS. State-of-the-art research perspectives on musculoskeletal disorder causation and control: the need for an intergraded understanding of risk. *J Electromyogr Kinesiol* 14: 1-5, 2004.
10. MORRIS JN, HEADY JA, RAFFLE PA, ROBERTS CG and PARKS JW. Coronary heart-disease and physical activity of work. *Lancet* 265: 1111-1120, 1953.
11. Paffenbarger RS. Contributions of epidemiology to exercise science and cardiovascular health. *Med Sci Sports Exerc* 20(5): 426-438, 1988.
12. Punnett L and Wegman DH. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *J Electromyogr Kinesiol* 14: 13-23, 2004.
13. Saltin B and Grimby G. Physiological analysis af middle-aged and old former athletes. *Circulation* 38: 1104-1115, 1968.
14. Sjøgaard G and Jensen BR. Low-Level Static Exertions. In: *Fundamentals and Assessment Tools for Occupational Ergonomics*, edited by William S Marras and Waldemar Karwowski. Boca Raton, FL 33487/USA: Taylor&Francis, CRC press, 2006, p. 14-1-14-13.
15. Sjøgaard G, Rosendal L, Kristiansen J, Blangsted AK, Skotte J, Larsson B, Gerdle B, Saltin B and Sogaard K. Muscle oxygenation and glycolysis in females with trapezius myalgia during stress and repetitive work using microdialysis and NIRS. *Eur J Appl Physiol* 108: 657-669, 2010.
16. Sjøgaard G, Sogaard K, Hermens HJ, Sandsjö L, Läubli T, Thorn S, Vollenbroek-Hutten MMR, Sell L, Christensen H, Klipstein A, Kadefors R and Merletti R. Neuromuscular assessment in elderly workers with and without work related shoulder/neck trouble: the NEW-study design and physiological findings. *European Journal of Applied Physiology* 96: 110-121, 2006.
17. Sjöström M, Oja P, Hagströmer M, Smith BJ and Bauman A. Health-enhancing physical activity across European Union countries: the Eurobarometer study. *J Public Health* 2006.
18. Struensee JF. *De incongrui corporis motus insalbritate* [On unhealthy bodily movements]. Halae: Litteris Gebauerianis, 1757.
19. Takala EP, Pehkonen I, Forsman M, Hansson GA, Mathiassen SE, Neumann WP, Sjøgaard G, Veiersted KB, Westgaard RH and Winkel J. Systematic evaluation of observational methods assessing biomechanical exposures at work. *Scand J Work Environ Health* 36: 3-24, 2010.





**Eira Viikari-Juntura** is Research Professor and Director of the Musculoskeletal Centre within the Finnish Institute of Occupational Health, Helsinki Finland. She is also Team Leader of the Work-Related Disorders Team, Assistant Editor in Chief of the Scandinavian Journal of Work Environment & Health, and senior lecturer at the University of Helsinki. She is MD, PhD and specialist in physical medicine and rehabilitation. She has worked as Visiting Professor at the University of Washington and Professor in Rehabilitation Medicine at Göteborg University and Chief Medical Officer at Sahlgrenska University Hospital in Sweden. Her areas of scientific interest include epidemiology of musculoskeletal disorders, diagnostics and functional capacity assessment, assessment of exposure and intervention studies. She is the founding member and previous Chair of the Scientific Committee for Musculoskeletal Disorders within ICOH.

## LIFESTYLE FACTORS IN MUSCULOSKELETAL DISORDERS (MSDs)– IMPLICATIONS FOR RESEARCH

VIIKARI-JUNTURA E.

*Finnish Institute of Occupational Health, Helsinki, Finland*

The current understanding is that several individual and environmental factors play a role in the etiology of various MSDs. The presentation will focus on lifestyle factors, such as overweight and obesity, smoking and physical activity and their effects on various musculoskeletal outcomes.

### **Associations of lifestyle factors with MSDs**

One or more lifestyle factors have been taken into consideration in most epidemiological studies on MSDs; however their independent effects and especially their role in modifying the effects of work environmental factors have been rarely addressed. Moreover, the selected factors and the methods to measure and classify them vary between studies. Consistent understanding on their role has therefore been difficult to obtain and even systematic reviews have sometimes given conflicting results.

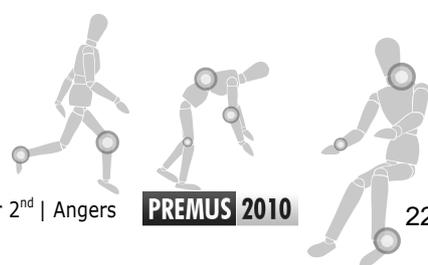
#### **Overweight and obesity**

The association of overweight and obesity with low back pain (LBP) have been addressed in a number of original studies and one earlier systematic review that have resulted in inconsistent findings. A recent systematic review that evaluated the studies according to four biases (selection, performance, detection, and attrition bias) included 95 studies in the systematic review and 33 studies in meta-analyses. The findings indicated that both overweight and obesity increase the risk of LBP. They had the strongest association with seeking care for LBP and chronic LBP (1).

Body mass index (BMI) has been most widely used in studies on obesity and LBP. It has, however, been discussed that BMI may not be an ideal measure of obesity, since it measures both body fat and lean body mass and does not reflect well fat distribution (2). A couple of studies have found that measures of abdominal obesity, such as waist circumference, have shown a stronger association with LBP than BMI. Future studies should use several measures to address weight-related factors. Better indicators of obesity will assist in better understanding the mechanisms behind the associations of obesity with LBP.

#### **Smoking**

The associations of smoking and LBP have likewise been inconsistent according to earlier studies. Using similar quality assessment as above, a systematic review included 81 studies, in which 40 were included in meta-analyses. The results showed that both current and former smokers have a higher prevalence and incidence of LBP than never smokers, but the association was fairly modest. Former smokers had a higher prevalence of LBP compared with never smokers, but a lower prevalence of LBP than current smokers, suggesting that cessation of smoking might prevent LBP. The association between current smoking and the incidence of LBP was stronger in adolescents than in adults, suggesting higher vulnerability of younger subjects to the effects of smoking or less exposure to other risk factors (3).



### Physical activity

According to a review published ten years ago, studies on the relationship between leisure time physical exercise and musculoskeletal disorders in worker populations showed inconsistent results (4). Two later reviews addressed the relationship of physical capacity measures (that can be assumed to correlate with physical activity) with low back and neck pain (5) and sedentary lifestyle (as a countermeasure of physical activity) with LBP (6). Low trunk muscle endurance is not a predictor of LBP, and inconsistent results have been found for low back muscle strength and mobility. Sedentary lifestyle does not seem to be associated with LBP. The associations of physical activity with musculoskeletal disorders are a conspicuously difficult topic for an epidemiological approach, since physical activity in general can be expected to have beneficial effects by strengthening the musculoskeletal tissues. However, certain types of activities and sports may have injurious effects, and a systematic review showed that physical activity indeed was associated with increased risk of sciatic pain (7). Furthermore, the interpretation of epidemiological data is difficult, since subjects with musculoskeletal symptoms may either increase or decrease their physical activity as an attempt to alleviate their symptoms. Finally, physical activity and obesity are linked with each other, lack of physical activity leading to obesity and vice versa (8).

### Other cardiovascular risk factors

Obesity, smoking and physical inactivity are all risk factors of cardiovascular diseases. Some studies have addressed the association of a wider set of cardiovascular risk factors in low back disorders, including serum lipids. In a representative population sample of males an association was found between measured levels of serum cholesterol (total and LDL cholesterol) and triglycerides with clinically assessed sciatica, allowing for several possible confounders (9). To directly test the association between atherosclerosis and sciatica, a subsample was studied of the Finnish Health 2000 population to whom measurements of carotid artery intima-media thickness (a measure of general atherosclerosis) had been performed by ultrasound. Carotid intima-media thickness was associated with continuous radiating LBP and with a positive unilateral clinical sign of sciatica among men (10). These findings suggest that MSDs and CVDs have common risk factors and may also share common pathomechanical pathways.

### Effects of modification of lifestyle factors

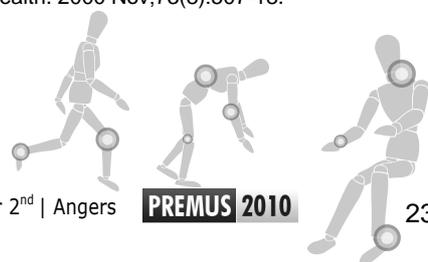
While there is evidence from observational epidemiological studies that some lifestyle factors are risk factors of MSDs, what is the evidence from intervention studies in which one or a set of lifestyle factors have been targeted? There seem to be no well-designed studies to assess the effects of weight reduction or smoking cessation. Lifestyle interventions have typically looked at physiological and cardiovascular outcomes, and few studies have looked at the musculoskeletal system. A multidisciplinary lifestyle intervention study targeted at hypertension looked also at LBP, neck pain and shoulder pain and associated disability. The intervention aimed to reduce hypertension was not effective at reducing prevalence of LBP or disability. However, in the subgroup of persons doing moderate or heavy work, the intervention seemed to reduce prevalence of LBP during the 1-year follow-up (11). There was also an effect on disability due to neck pain and a slight effect on shoulder pain in the intervention group. Various forms of therapeutic exercises have been used in the secondary prevention of low back and neck pain and shown consistent moderate effect to prevent symptoms from becoming chronic (12).

### Summary and implications for further research

Lifestyle factors, e.g. overweight/obesity and smoking are risk factors for LBP and some other musculoskeletal disorders. The independent effects are typically moderate; however the joint effects of different lifestyle factors and the joint effects of lifestyle factors and environmental factors are largely unknown (13). Future studies should address these questions when large representative population samples are available. The metabolic and hormonal background of men and women differ; therefore gender specific analyses are recommended. Although few intervention studies have been targeted at lifestyle factors with an MSD as a primary outcome, available evidence from observational studies suggests that health promotion should be considered both in primary and secondary prevention of MSDs.

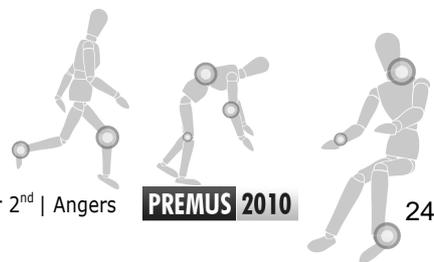
### References

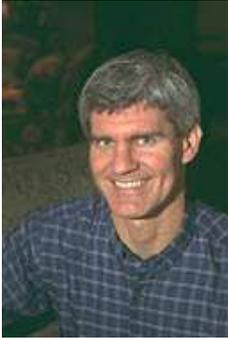
1. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The Association Between Obesity and Low Back Pain: A Meta-Analysis. *Am J Epidemiol*. 2010 Jan 15; 171(2):135–54. Epub 2009 Dec 11.
2. Sniijder MB, van Dam RM, Visser M, et al. What aspects of body fat are particularly hazardous and how do we measure them? *Int J Epidemiol* 2006;35:83–92.
3. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The Association Between Smoking and Low Back Pain: A Meta-Analysis. *Am J Med*. 2010 Jan; 123(1):87.e7-35.
4. Hildebrandt VH, Bongers PM, Dul J, van Dijk FJ, Kemper HC. The relationship between leisure time, physical activities and musculoskeletal symptoms and disability in worker populations. *Int Arch Occup Environ Health*. 2000 Nov;73(8):507-18.



## Keynotes - Lifestyle factors in musculoskeletal disorders (MSDs) – Implications for research

5. Hamberg-van Reenen HH, Ariëns GA, Blatter BM, van Mechelen W, Bongers PM. A systematic review of the relation between physical capacity and future low back and neck/shoulder pain. *Pain*. 2007 Jul;130(1-2):93-107. Epub 2007 Jan 11.
6. Chen SM, Liu MF, Cook J, Bass S, Lo SK. Sedentary lifestyle as a risk factor for low back pain: a systematic review. *Int Arch Occup Environ Health*. 2009 Jul;82(7):797-806. Epub 2009 Mar 20.
7. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Varonen H, Kalso E, Ukkola O, Viikari-Juntura E. Cardiovascular and lifestyle risk factors in lumbar radicular pain or clinically defined sciatica: a systematic review. *Eur Spine J*. 2007 Dec;16(12):2043-54. Epub 2007 May 25.
8. Pietiläinen KH, Kaprio J, Borg P, Plasqui G, Yki-Järvinen H, Kujala UM, et al. Physical inactivity and obesity: a vicious circle. *Obesity (Silver Spring)* 2008;16(2):409-14.
9. Leino-Arjas P, Kauppila L, Kaila-Kangas L, Shiri R, Heistaro S, Heliövaara M. Serum lipids in relation to sciatica among Finns. *Atherosclerosis*. 2008 Mar;197(1):43-9. Epub 2007 Sep 7.
10. Shiri R, Viikari-Juntura E, Leino-Arjas P, Vehmas T, Varonen H, Moilanen L, Karppinen J, Heliövaara M. The association between carotid intima-media thickness and sciatica. *Semin Arthritis Rheum*. 2007 Dec;37(3):174-81. Epub 2007 May 15.
11. Mattila R, Malmivaara A, Kastarinen M, Kivelä SL, Nissinen A. The effects of lifestyle intervention for hypertension on low back pain: a randomized controlled trial. *Spine* 2007 Dec 15;32(26):2943-7.
12. Linton SJ, van Tulder MW. Preventive interventions for back and neck pain problems: what is the evidence? *Spine*. 2001 Apr 1;26(7):778-87..
13. Schulte PA, Wagner GR, Ostry A, Blanciforti LA, Cutlip RG, Krajnak KM, Luster M, Munson AE, O'Callaghan JP, Parks CG, Simeonova PP, Miller DB. Work, obesity, and occupational safety and health. *Am J Public Health*. 2007 Mar;97(3):428-36. Epub 2007 Jan 31.





**David Rempel, MD, MPH**

David Rempel is Professor of Medicine at the University of California, San Francisco, Professor of Bioengineering at UC Berkeley, and director of the ergonomics graduate training program at UC Berkeley. The research of his group has focused on understanding mechanisms of injury to tendon and nerve due to cyclical loading and the application of this information to the design of tools and work in order to prevent musculoskeletal disorders. His recent research has involved workplace intervention studies in the garment, dental, construction, and office sectors. The publications of the group and a description of the graduate training program are at:

<http://ergo.berkeley.edu/>.

## PREVENTION OF CARPAL TUNNEL SYNDROME: LESSONS FROM PHYSIOLOGIC STUDIES

REMPEL D.

*Division of Occupational and Environmental Medicine, University of California, San Francisco, USA*

Consensus is lacking on the precise role of workplace biomechanical factors in the causation of CTS. Epidemiologic studies are limited in their ability to clarify the dose-response relationships because the incidence of CTS is low, the exposure patterns at work and home are complex, and there is lack of agreement on measuring and aggregating biomechanical exposures (van Rijn 2009). However, some light can be shed on the relationship between biomechanical factors and the pathophysiology of activity-related CTS by examining findings from human and animal physiologic studies. Human histologic and intraoperative studies provide insights into the tissue changes in synovium and nerve and the location of damage. Animal studies provide support for the mechanism of injury. And human studies of carpal tunnel pressure provide detailed information on the relationships between biomechanical factors and a mediator of injury: elevated intracarpal pressure.

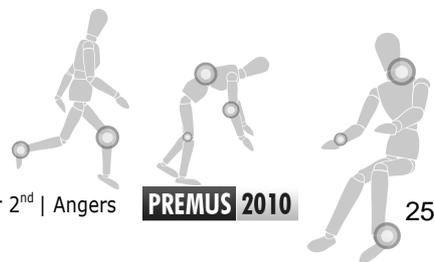
We know that patients with CTS have elevated fluid pressure in the carpal tunnel compared to healthy controls. Furthermore, we know that in patients with CTS and in healthy subjects, the pressure in the tunnel can increase by external compression or by moving the wrist toward posture extremes. The pressure remains elevated for as long as the wrist is manipulated because there is no lymphatic drainage.

The role of elevated fluid pressure in causing peripheral nerve injury is supported by animal studies. Powell and Meyers (1986) applied small inflatable cuffs around the rat sciatic nerve for just two hours then examined the nerve one month later. Pressures of 0 or 10 mm Hg had little effect while pressures of 30 mm Hg caused subperineurial edema and demyelination and pressures of 80 mm Hg led to epineurial fibrosis.

So understanding how hand postures and loads increase carpal tunnel pressure may provide insights into how to prevent CTS in the workplace. A physiologic model is gaining support that explains the relationship between hand postures and tunnel pressures. The model considers the carpal tunnel as a closed compartment. The boundaries are stiff enough to sustain an elevated fluid pressure. As the boundaries change with changes in wrist and finger the tunnel pressure changes. Half the contents of the tunnel are stiff flexor tendons that traverse the tunnel. These will not deform but they move within the tunnel with changes in finger loading (Yoshii 2009). The other half is the tenosynovium that surrounds the tendons and the median nerve. The tenosynovium is a gel-like material that can sustain a fluid pressure gradient within the tunnel. Therefore, the pressure in one region of the tunnel may be different from another region.

The tunnel is narrowest at the hook of the hamate. Intraoperative studies of patients with CTS report that the greatest narrowing of the median nerve occurs at the level of the hook of the hamate and the nerve is enlarged just proximal to the hook. A recent primate model of CTS revealed that repetitive, forceful grasping for several weeks not only caused nerve slowing but also caused enlargement of the median nerve in the location similar to that seen in humans.

Several laboratories have been mapping the relationships between hand/wrist postures, forearm rotation, fingertip loading and carpal tunnel pressure. Pressure is increased by wrist extension or flexion. Supination and full pronation increase pressure. Fingertip loading increases CTP. External compression increases CTP. But there are large between-subject differences. Some of these differences may be due to differences



in methods of measuring pressure. For example, small changes in the location of the pressure sensor within the carpal tunnel may have a large influence on the pressure pattern.

Understanding the relationship between hand and wrist postures and fingertip loading and carpal tunnel pressure may provide guidelines for improving the design of work to prevent CTS. A study of pinching found a relatively linear relationship between pinch force and carpal tunnel pressure with pinch forces of 5N or 10 N associated with pressures of 30 and 40 mmHg, respectively. For pronation/supination, the lowest carpal tunnel pressure is at 45 degrees pronation. For finger flexion, the pressure is lowest at 45 degrees MCP flexion.

The proposed model suggests that tools and hand tasks be designed so that the mean pressure in the tunnel is as low as possible or stays below some pressure associated with tissue injury. We recently proposed that, based on an injury threshold of 30 mmHg, the mean wrist postures that protect 75% of the population are 32.7° extension, 48.6° flexion, 21.8° radial deviation, and 14.5° ulnar deviation (Keir 2007). Similar guidelines could be developed for pinch force, finger postures, and wrist contact stress.

This approach may provide guidance for static postures and loading but the hand is active at work. Hand activity is dynamic and the pressures in the carpal tunnel can change rapidly. For example, pressure is elevated during a material handling task, similar to that of grocery clerk checker, when an object is gripped. But the pressure rapidly drops when the object is released. For keyboard work the mean pressure is primarily determined by wrist posture and contact stress during keying; this can be considered a static load. The dynamic act of keying increases the mean pressure by an additional 5 mmHg but the pressure fluctuates.

Determining the relationships between nerve compression pressure, compression time, and recovery time that prevent an ischemic reperfusion injury of the synovium or nerve is a ripe area for research. Is the primary determinant of injury the exposure duration to peak pressures, to mean pressures, or an inadequate time to some minimal pressure that allows for tissue perfusion? A study of the rat sciatic nerve exposed it to static and cyclic pressures. Nerve function was influenced by mean tissue pressure not peak pressure. But do pressure patterns that cause an acute change in nerve function also initiate the more serious changes of demyelination or fibrosis?

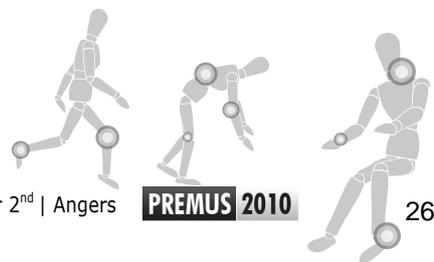
**Keywords:** Mechanism, Early prevention, CTS

**References:**

Keir PJ, Bach JM, Hudes M, Rempel DM. Guidelines for wrist posture based on carpal tunnel pressure thresholds. *Human Factors* 2007; 49:88-89.

Powell HC, Myers RR. Pathology of experimental nerve compression. *Laboratory Investigation*. 1986; 55:91-100.

van Rijn RM, Huisstede BMA, Koes BW, Burdorf A. Associations between work-related factors and the carpal tunnel syndrome – a systematic review. *Scand J Work Environ Health* 2009; 35:19-36.





**François Daniellou** is Professor of Ergonomics at the Institute of Technology of Bordeaux University. His research field is the introduction of ergonomics in design project management, with emphasis on musculoskeletal disorders, psychosocial risks and technological accidents prevention. The International Ergonomics Association bestowed him the 2009 Outstanding Educators Award.

francois.daniellou@ensc.fr

## MSD PREVENTION: THE ORGANISATIONAL CHALLENGE

DANIELLOU F.

*IPB-ENSC, Université de Bordeaux, France*

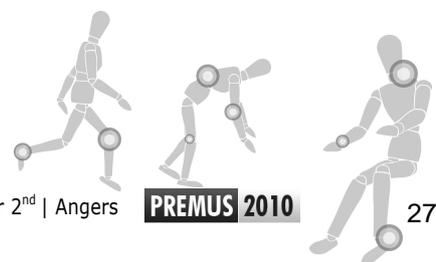
MSD risk factors that are commonly addressed, such as repetitiveness, strength, posture, have themselves higher level determinants (Bellemare et al., 2002). Those are product design, production organisation, workplace design choices, human resource management, general management style, and so on. The main prevention challenge is to tackle not only the risk factors at the workplace but their sources in the organisation. This requires a model of the relations between macro determinants and micro consequences, and models of efficient prevention interventions.

Any workplace is a place where meet: i) an anticipation of production operations, made by the designers and organisers by means of general knowledge (and beliefs); ii) an ability to cope with the real time variability of production components, that is made of individual embodied knowledge and collective rules of the trade. In most situations, the organisation underestimates the level of variability, what is required from the workers to cope with it, and the costs that the discrepancy implies. Therefore, the workers undergo a lack of room for manoeuvre to deal with what has not been anticipated. Production cycles never go as they are supposed to, and the micro reality requires a constant effort of the workers to deal with incidents. MSDs are often a consequence of organisations who aim at a high level of production flexibility with a high organisational rigidity. An assessment of biomechanical risk factors carried out on the basis of a normal standard cycle has little to do with the ongoing accelerations and stops that really occur.

A 3 year study about “sustainable MSD prevention” (Caroly et al, 2007, Coutarel et al., 2006) in middle size companies in France has highlighted the extent to which organisations are frequently overwhelmed by the discrepancy between anticipation and real operations. This results into unofficial stocks, not adapted tools, series of accelerations and breakdowns, delays, quality defects, and so on. The lack of organisational feedback and taking in account of workers’ knowledge is obvious. The approximate translation of so-called “Japanese” organisational measures leads to a combination of organisational mess and an impossibility for the workers to criticize it. Hidden costs (absenteeism and its management, quality losses, delays, loss of brand image...) have been demonstrated to be 10 to 30 times as much as the direct cost of occupational diseases.

Addressing MSD prevention requires a collective awareness of the relation between health hazards and production pitfalls (Winkel & Neumann, 2007). Therefore, a specific project management may be developed, including following ingredients :

- MSDs are not (only) a medical problem, they are a strategic issue for the organisation. Therefore upper management’s involvement and commitment are required.
- MSD are one symptom of a more general organisational syndrome, which includes difficulties for the middle management and lack of decision power for the plant management. Production limitations must be addressed simultaneously with health hazards.
- MSD prevention requires new forms of dialog between all stake holders (decision makers, designers, personnel representatives, health staff, workers including middle management), and relevant forms of participation.

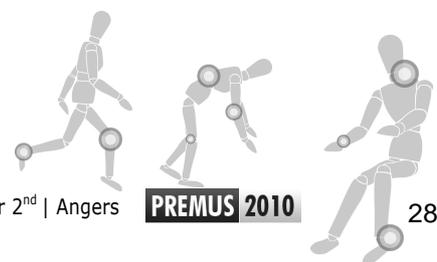


- One other symptom of the MSD syndrome is the general belief that “nothing else is possible”, which is a defence built by the actors in response to their feeling of impotence. Designing and implementing collectively quick solutions are not the final response, but may be a way to make it possible for the actors to overcome this hang-up.

MSD prevention requires experimentation of daring participatory forms of redesign project management. This raises an epistemological problem, since “randomized controlled trials” are not possible when the point is to show the relevance of specific forms of participation. An alternative is qualitative research, based on monographs. A detailed description of a number of interventions, including a systematically framed description of the request, the company context, the underlying theories and models of the consultants, the planned components of the intervention, their real implementation, and the assessed effects (Baril-Gingras et al., 2006, Bellemare et al., 2007, Berthelette, 2006, Messing et al., 2005) might provide a relevant database to detect regularities and feed the professional practice and teaching.

#### References:

- Baril-Gingras, G., Bellemare, M., Poulin, P., 2006, OHS external interventions qualitative analysis: an example of the contribution of social sciences, in International Congress of SafetyNet and l'Association canadienne de recherche en santé au travail / ACRST, (7-8 juin, 2006 : St-Jean, Terre-Neuve-et-Labrador, Canada).
- Bellemare, M., Marier, M., Montreuil, S., Allard, D., Prévost, J., La transformation des situations de travail par une approche participative en ergonomie : une recherche intervention pour la prévention des troubles musculo-squelettiques, Rapport R-292, Montreal : IRSST, [http://www.irsst.qc.ca/fr/\\_publicationirsst\\_824.html](http://www.irsst.qc.ca/fr/_publicationirsst_824.html)
- Bellemare, M., Baril-Gingras, G., Poulin, P., Ross, J., 2007, Analysis of the socio-organizational aspects of an intervention: tool for process evaluation studies, in Proceedings of PREMUS 2007 : Sixth International Scientific Conference on Prevention of Work-related Musculoskeletal Disorders, p. 140
- Berthelette, D., Leduc, N., Bilodeau, H., Faye, C., Loignon, C., 2006, From Underlying Theory to Program Delivery: The Safe Patient Transfer Training Program. Proceedings of the 16th World Congress on Ergonomics, International Ergonomics Association, Maastricht, The Netherlands
- Caroly, S., Coutarel, F., Daniellou, F., Landry, A., Escriva, E., Roquelaure, Y., 2007. Assessment of the interventions of sustainable prevention of musculoskeletal disorders : comparison of twenty companies. Proceedings of PREMUS 2007, Sixth international scientific conference on prevention of work-related musculoskeletal disorders, Boston, USA
- Coutarel, F., Daniellou, F., Dugué, B., Landry, A., Caroly, S., Cholez, C., Roquelaure, Y. and Douillet, P., 2006, Sustainable prevention of musculoskeletal disorders: methodological aspects of a project on assessment of the efficiency of interventions, Proceedings of International Ergonomics Association Congress, Maastricht.
- Messing, K., Seifert, A.M., Vézina, N., Balka, E., Chatigny, C., 2005. Qualitative research using numbers: Analysis developed in France and used to transform work in North America. *New Solutions: A Journal of Environmental and Occupational Health Policy* 15(3): 245-260
- Winkel, J. and Neumann, P., 2007, Ergonomics and effective production systems – moving from reactive to proactive development, Stockholm, Swedish National Institute for Working Life.





**Philippe Mairiaux, MD, Ph.D**

Dr Mairiaux is Professor in Public Health, Occupational Health and Ergonomics at the University of Liège Medical School, Belgium. His research main areas of interest are prevention of work related musculoskeletal disorders, return to work strategies for injured workers and participatory strategies for risk assessment in the industry. He has been consultant in disability prevention for a large steel company. He is presently chair of the Belgian Fund for Occupational Diseases scientific Council and the scientific advisor of its Task force in charge of coordinating the Belgian project for prevention of chronic low back pain.

## MANAGEMENT OF LOW BACK PAIN AND THE WORKING ENVIRONMENT

MAIRIAUX P.

*School of Public Health, University of Liège, Belgium*

How can we translate scientific evidence and knowledge about occupational back pain in effective and affordable prevention policies in the working environment? This will be the main focus of the presentation.

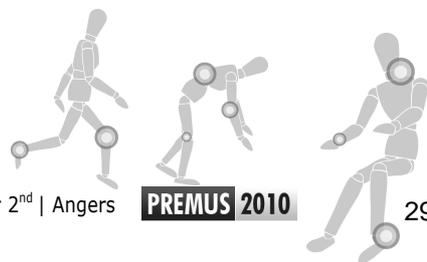
It is commonly acknowledged that non-specific low back pain (LBP) is a widespread health complaint among adults of working age, frequently affecting their capacity for work, causing loss of work time, putting sometimes in jeopardy the worker's employability and requesting from the OH services and professionals early recognition, adapted prevention and management strategies. Those unfavorable effects are mostly ascribed to the chronic or recurrent forms of low back pain (CLBP).

From a public health perspective, CLBP is the main reason of about 30 of the cases being granted permanent disability benefits in developed countries (the top cause being mental disorders) and this is a reason of concern when considering the continuous increase in early retirement for health reasons observed after 50 years of age. However from a business perspective, if occupational LBP may have negative impacts in terms of sickness absences rate or early retirement, the extent of those impacts is actually function of each country wage replacement system. When the system relies directly on the company budget, the managers have a stronger incentive for LBP management than when the financing of the system is indirect, through the taxpayer for instance.

In this context, management of LBP at the company level will be discussed in its wide sense, including all interventions aiming to prevent LBP in healthy workers (primary prevention), or to care for workers with sub acute LBP to prevent their transition to chronicity (secondary prevention) and to promote their return to work.

When considering early (or primary) prevention, policies have been based for 40 years or more on two axes : ergonomics interventions aiming at reducing biomechanical constraints through implementation of physical modifications or mechanical lifting equipment at the workplace, and workers training in "safe" handling techniques. Unfortunately, scientific studies have consistently failed in proving the effectiveness of those prevention policies. Two recent systematic reviews confirm this trend. In their review, Martimo et al (2008) concluded that there is no evidence to support the use of training in work techniques as a way to prevent LBP. On the other hand, Driessen et al (2010) showed that physical or organizational ergonomics interventions were not more effective on LBP than no intervention. Whereas more and more ergonomists stress the key influence that workers participation may have on effective improvements in working conditions, a randomized control trial (RCT) involving a substantial degree of participative ergonomics was not successful in preventing musculoskeletal disorders among kitchen workers (Haukka et al 2008). Hence is it time for leaving aside those widespread prevention practices? Is risk factors reduction a logical dead end as long as primary causative mechanisms of low back pain are not determined? Or should we question conclusions drawn from a limited number of RCT's type studies? Should ergonomists and other prevention practitioners reconsider the content of the interventions in order to design really multidimensional interventions? The presentation will bring its own contribution to this heated debate by introducing additional thoughts from a practitioner point of view.

Another option for LBP prevention strategies would be instead of aiming at etiologic factors, to focus on those prognostic factors that influence the duration and consequences (sick leave, disability, health care



consumption,...) of low back pain. Solid scientific evidence show indeed the effectiveness on disability of various interventions designed to promote an early return to work (RTW). Since the pioneering work of Loisel and co-workers (1997), workplace based RTW interventions have shown to be effective, among sub acute LBP workers and in comparison to usual care, on return to work rate and reduction of the number of days of absence from work at short and medium terms, even if improvements in functional status or pain are not often observed (Hlobil et al 2005). There is however still some controversy concerning the optimal content of a RTW program, and the balance to ensure in those programs between the medical rehabilitation component (graded activity) and the ergonomic or occupational health component to deliver at the workplace itself (van Oostrom et al 2009). Nonetheless the evidence is now sufficient to promote those RTW policies in the working environment.

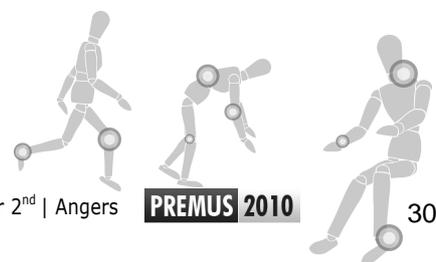
The actual implementation of RTW programs in companies and businesses raises however several challenges. First, it must be pointed out that large companies, mainly multinational companies, are traditionally prone to adopt innovations that they see as cost savings measures and in fact in many countries, large companies already make use of various forms of return to work measures or programs. This positive evolution may however enlarge in the future the gap between the workforce employed in 1st class businesses and the rest of the working population, increasing thus the inequalities in health due to the working environment. Translation of scientific knowledge into practice should thus in our view imply an universal approach giving every worker, whatever the size or type of company he/she is working for, access to measures facilitating return to work. Such an universal access could be achieved through legislation and its implementation carried out either through the social insurance system, or through the occupational health system where it exists.

Modifying legislation and implementing new practices in a social insurance system implies at least two other challenges: putting on board for such a reform all the stakeholders (social insurers, employers, trade unions, ...) and modifying the common beliefs and daily behaviours of all health professionals involved in the process (general practitioners, occupational health physicians, social insurance physicians). Taking as example the implementation process of a RTW program for low back pain workers initiated in Belgium in 2005, at the country level, we will outline several key factors that may influence success or failure of a scientifically sounded program at its implementation stage. One of the most evident difficulty is to close the gap between the "prevent" and "cure" paradigms.

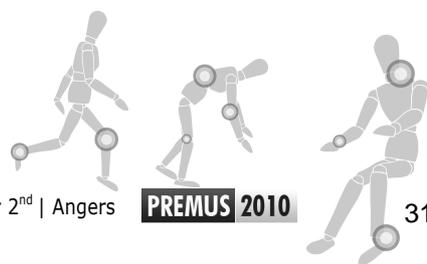
In conclusion, the presentation will show the interest that companies and businesses may have in integrating secondary and primary prevention of low back pain in a broad "quality of life" at work policy.

#### References:

- Nielens H., Van Zundert J. Mairiaux P. Gailly J. Van Den Hecke N. Mazina D. Camberlin C. Bartholomeeussen S. De Gauquier K. Paulus D. Ramaekers D. Chronic low back pain. Good clinical practice (GCP). Bruxelles: KCE (Centre Fédéral d'Expertise des soins de santé); 2006. Report No.: 48B
- Loisel P, Abenhaim I, Durand P, Esdaile JM, Suissa S, Gosselin L et al. A population-based, randomized clinical trial on back pain management. *Spine* 1997;22(24):2911-8.
- Hlobil H, Staal JB, Spoelstra M, Ariens GA, Smid T, Van Mechelen W. Effectiveness of a return-to-work intervention for subacute low-back pain. *Scandinavian Journal of Work, Environment & Health* 2005 August;31(4):249-57.
- Anema JR, Steenstra IA, Bongers PM, de Vet HC, Knol DL, Loisel P, van Mechelen W, Multidisciplinary Rehabilitation for Subacute Low Back Pain: Graded Activity or Workplace Intervention or Both?: A Randomized Controlled Trial. *Spine* 2007; 32:291-98
- Schaafsma F, Schonstein E, Whelan KM, Ulvestad E, Kenny DT, Verbeek JH. Physical conditioning programs for improving work outcomes in workers with back pain. *Cochrane Database Syst Rev*. 2010 Jan 20;(1):CD001822.
- van Oostrom SH, Driessen MT, de Vet HC, Franche RL, Schonstein E, Loisel P, van Mechelen W, Anema JR. Workplace interventions for preventing work disability. *Cochrane Database Syst Rev*. 2009 Apr 15;(2):CD006955



# SYMPOSLIA



## **DIFFERENT ASPECTS OF THE PROGNOSIS OF MUSCULOSKELETAL DISORDERS IN OCCUPATIONAL SETTINGS: EXAMPLE OF THE CARPAL TUNNEL SYNDROME.**

### ***Symposium Description***

Prognosis of musculoskeletal disorders in occupational setting is an essential point for workers and populations. Prognosis includes different aspects of the outcome, medical, socioeconomic, well-being... Carpal tunnel syndrome is a good example of this multiple aspect of prognosis.

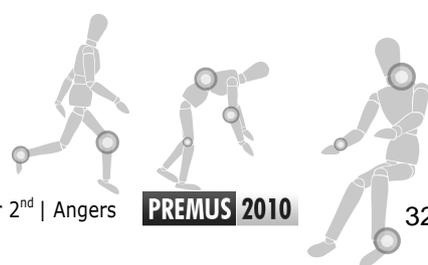
We aimed in this symposium illustrates this point by different point of view of the prognosis of carpal tunnel syndrome in occupation setting.

### ***Symposium Author***

Dr. Alexis DESCATHA

### ***Authors linked to the symposium***      ***Name of their abstract***

COGGON D.	Epidemiological investigation on prognosis.
CESARI B.	In a clinical point of view, what are the strongest predictors of the medical prognosis for carpal tunnel syndrome?
DESCATHA A.	What are the strongest predictors of the medical prognosis of CTS? Results from a US population based study.
PAROT-SCHINKEL E.	What are the strongest predictors of the return to work for carpal tunnel syndrome? Results from a French population based study.
PRANSKY G.	Prognosis for return to work in carpal tunnel syndrome: a north American perspective



## EPIDEMIOLOGICAL INVESTIGATION OF PROGNOSIS.

COGGON D.

*MRC Epidemiology Resource Centre, University of Southampton, UK*

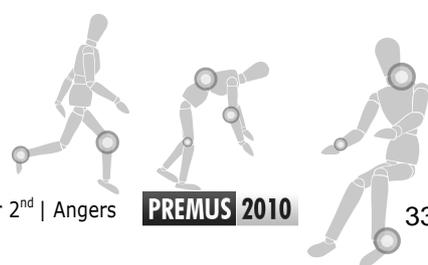
Knowledge of prognosis and its important predictors is of value in the clinical management of illness and disease, and also in the planning of research to assess treatments. Information about prognosis can be generated by longitudinal studies, in which potential predictors of outcome are assessed, and then patients are followed up systematically to ascertain relevant outcomes. In addition, it may be necessary to document factors (e.g. treatments) during follow-up that could modify the occurrence of outcomes.

As in aetiological studies, regression analyses can be used to explore the associations of risk factors with outcomes, and the impact of other factors that might modify relationships. However, unlike in studies of causation, confounding is not a consideration. Rather, the aim of the analysis is to identify the combination of prognostic variables that will give the most cost-effective discrimination of outcome probabilities, whether or not those variables are causes of the outcome.

In considering the value of one prognostic algorithm as compared with another, odds ratios and relative risks are of less consequence than positive and negative predictive values and the proportion of the variability in prognosis that is explained by the combination of variables under consideration.

Because of regression to the mean, the level of prediction that is achieved with the data that are used to select prognostic models will not normally be achieved when the same models are applied to other datasets. Therefore, when developing prognostic models, it is a good practice to evaluate them in an independent dataset.

**Keywords:** Methods in epidemiology, Prognosis of MSD.



## **IN A CLINICAL POINT OF VIEW, WHAT ARE THE STRONGEST PREDICTORS OF THE MEDICAL PROGNOSIS FOR CARPAL TUNNEL SYNDROME?**

CESARI B., RAIMBEAU G., FOUQUE P.A., SAINT-CAST Y., RABARIN F., JEUDI J.

*Centre de la Main, 2 rue Auguste Gautier, 49100 ANGERS, FRANCE*

### **Aims:**

Carpal tunnel syndrome often requires surgery among working population. Although long term outcome is usually good, and recurrences after surgery are rather sparse, returning to work can be difficult. This presentation scans, from the surgeon's clinical point of view, factors that influence the outcome after surgery.

### **Results:**

Associations with other medical problems, especially other upper limb or cervical disorders, are the most frequent and important factors that must be identified preoperatively and taken in charge. Several problems can maximize each others and compromise the outcome. When surgery is required, the sequence, with or after the carpal tunnel release, should be considered.

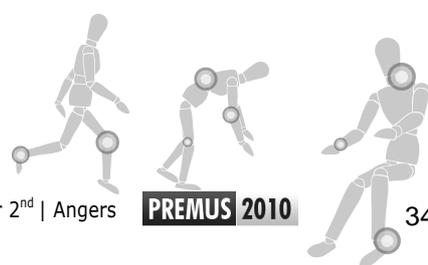
Occupations, economic conditions related to CTS, mental and functional status of the patient towards his own work can change the outcome of recovery.

The occurrence of a complex regional pain syndrome after surgery is related to long recovery and bad outcome.

### **Conclusion:**

Preoperative information, comfort during surgery, management of the postoperative pain and early use of the hand for daily activities are mandatory for a quick recovery but not always enough, and rehabilitation to work should be considered.

**Keywords:** Return to work, Upper limb, Carpal tunnel syndrome.



## WHAT ARE THE STRONGEST PREDICTORS OF THE MEDICAL PROGNOSIS OF CTS? RESULTS FROM A US POPULATION BASED STUDY.

DESCATHA A., DALE A.M., FRANZBLAU A., CALFEE R.P., EVANOFF B.

*Division of General Medical Sciences, Washington University School of Medicine, St. Louis, MISSOURI, USA*

### **Aims:**

We evaluated factors associated with three-year outcomes of subjects with hand symptoms in a population-based study in the United States.

### **Methods:**

Between July 2004 and October 2006, we enrolled 1107 newly employed industrial workers, without a pre-existing diagnosis of carpal tunnel syndrome (CTS) or peripheral neuropathy. At baseline, each worker received a nerve conduction study and completed a detailed questionnaire. Questionnaires were repeated at 6, 18, and 36 months, and included hand symptoms, self-reported work exposures, and psychosocial factors. Subjects were categorized according to baseline data into three groups: any hand symptoms (recurring symptoms in hands, wrist or fingers), symptoms of CTS (neuropathic symptoms in the fingers), or confirmed CTS (symptoms of CTS and abnormal nerve conduction study). The primary outcome at 3 years was "important hand pain" defined as hand pain experienced within the previous 30 days rated more severe than 5 out of 10 (0-no pain, 10-worst pain/discomfort). Baseline subject categorization and independent variables (medical, general, occupational) were assessed as prognostic factors for the primary outcome. We analyzed predictors of "important hand pain" at 3 year follow-up, using bivariate and multivariate logistic regression models.

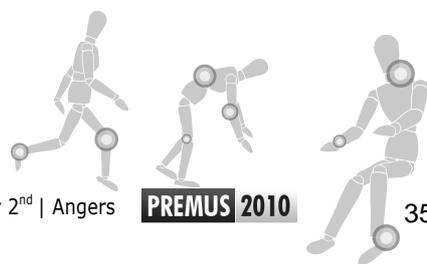
### **Results:**

At 3 years, follow up was completed on 880 workers (79.4%) with a mean age 30.1 years (range 18-66 years); 560 (63.6%) workers were men. Among the 154 symptomatic workers at baseline (17.5% of the cohort followed), 82 (53.2%) had recurrent hand symptoms, 52 (33.8%) symptoms of CTS, and 20 (13%) had confirmed CTS. At 3 years, 50 (32.5%) of workers who were symptomatic at baseline reported "important hand pain". Baseline categorization as "Confirmed CTS" was associated with having important hand pain at 3 year follow-up (60.0% versus 28.8%), as did lack of social support (52.2% versus 28.3%). Steroid injection in the three-year period was also associated with hand pain (80.0% versus 30.9%), but only five subjects received it. Reported repetitive wrist motion (baseline), Caucasian race, and surgery during the study period trended toward a better prognosis (not significant).

### **Conclusion:**

Industrial workers reporting hand pain at baseline demonstrate a high prevalence of continued hand pain 3 years later. Meeting a case definition of electrodiagnostically confirmed CTS at baseline was the greatest predictor of hand pain among these industrial workers at 3 years.

**Keywords:** Epidemiology, Carpal tunnel syndrome, Prognosis of MSD.



## WHAT ARE THE STRONGEST PREDICTORS OF THE RETURN TO WORK FOR CARPAL TUNNEL SYNDROME? RESULTS FROM A FRENCH POPULATION BASED STUDY.

PAROT-SCHINKEL E.<sup>1</sup>, ROQUELAURE Y.<sup>1</sup>, HA C.<sup>2</sup>, LECLERC A.<sup>3</sup>, CHASTANG J.F.<sup>3</sup>, DESCATHA A.<sup>3</sup>, RAIMBEAU G.<sup>4</sup>, CHAISE F.<sup>5</sup>

<sup>1</sup> Laboratoire d'ergonomie et d'épidémiologie en santé au travail, Unité associée InVS, Université d'Angers, Angers, France - <sup>2</sup> Institut de veille sanitaire, Saint-Maurice, France - <sup>3</sup> Inserm U687, Villejuif, France - <sup>4</sup> Centre de la Main, Angers, France - <sup>5</sup> Clinique Jeanne d'Arc, Nantes, France.

### Aims:

The aim of this study was to determine the strongest predictors of return to work for carpal tunnel syndrome (CTS) after surgical release of the median nerve.

### Methods:

Patients from the French Pays de la Loire region having undergone surgical release of the median nerve in 2002-2003, filled out a mailed questionnaire in 2004-2005. Cox's proportional hazards models, one for men and one for women, were performed to determine independent predictors of return to work and to estimate adjusted hazard ratios (HR). Analyses were restricted to patients employed at the time of the surgery. Variables were considered for inclusion in the multivariate models if they were significant at a  $p < 0.20$  level in the univariate analysis (Kaplan-Meier survival method and log-rank test).

### Results:

1,248 questionnaires were returned (62%). A total of 253 men and 682 women declared being employed at the time of the surgery. More than 90% of patients had returned to work at the moment of the questionnaire. The median duration of work disability was 60 days, the average duration was 70 days for men and 82 days for women. For men and women, a strong predictor for return to work was simultaneous intervention for another upper extremity musculoskeletal disorder (HR 2.2 for men and 1.4 for women). Conversely, belonging to the « white-collar workers » occupational category (reference: occupational category « blue-collar workers », HR 0.1 for men and 0.5 for women) was a good predictor for return to work. For women, two other strong predictors were further identified: sick leave compensated by the occupational health insurance system (HR 1.8) and belief (of the patient) in an occupational cause (HR 2.2).

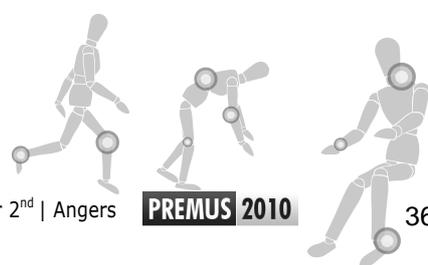
### Conclusion:

This study underlines the multifactorial nature of the prognosis for returning to work after surgery for CTS. To identify persons with a low probability of return to work, a complete evaluation must be carried out before and after surgery. For these people, the medical, social and occupational management must be adapted to facilitate a quick return to work and to reduce the risk of occupational disability.

**Keywords:** Carpal tunnel syndrome, Return to work, Prognosis of MSD.

### References:

- Chaise F, Bellemere P, Friol J-P, Gaisne E, Poirier P, Menadi A. Professional absenteeism and surgery for carpal tunnel syndrome. Results of a prospective series of 233 patients. *Chir Main*. 2001;20:117-21.
- Katz J-N, Losina E, Amick B-C, Fossel A-H, Bessette L, Keller R-B. Predictors of outcomes of carpal tunnel release. *Arthritis Rheum*. 2001;44:1184-93.
- Katz J-N, Amick B-C, Keller R, Fossel A-H, Ossman J, Soucie V, Losina E. Determinants of work absence following surgery for carpal tunnel syndrome. *Am J Ind Med*. 2005;47:120-30.



## **PROGNOSIS FOR RETURN TO WORK IN CARPAL TUNNEL SYNDROME: A NORTH AMERICAN PERSPECTIVE**

PRANSKY G.

*Liberty Mutual Research Institute for Safety, Hopkinton, MASSACHUSETTS, USA*

### **Aims:**

Carpal Tunnel Syndrome (CTS) affects more than 10% of adults during their working years, and CTS surgery is the most common orthopedic procedure in the United States. Because CTS often has a significant impact on work function, there is considerable interest in return to work (RTW) after CTS surgery. This analysis was intended to provide an overview of return to work outcomes and associated factors.

### **Methods:**

Selective review of North American studies reporting work outcomes and associated factors after CTS surgery, in workers, published since 1995. Results were examined within the context of a biopsychosocial, multi-dimensional model of work disability.

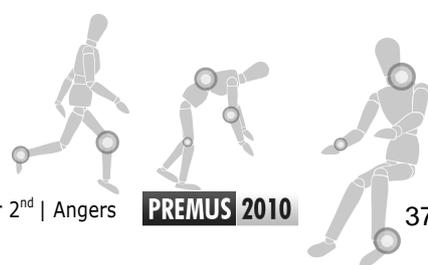
### **Results:**

In 15 studies, representing a total of 3,078 patients followed for six months or more, the overall return to work rate at six months ranged from 65-100%, with a mean duration of work absence of 27-90 days after surgery. A few studies documented persistent difficulty in performing work functions, decreased income, or recurrent symptoms even after successful return to work. The most consistent factors related to prolonged post-operative disability included workers' compensation, attorney representation, other hand problems (especially tendonitis), heavy physical job demands, low decision latitude, severity of persistent symptoms after surgery, poor general health, and lower socioeconomic status. Gender, self-employment, persistence of mild CTS symptoms, and type of surgery had small, inconsistent relationships with RTW outcomes. One controlled study demonstrated no benefit on RTW from post-operative physical therapy.

### **Conclusion:**

As in other work-related conditions, rates and length of time to RTW do not provide a comprehensive picture of the long-term occupational impact of a musculoskeletal disorder. Similar workplace factors also are most strongly related to RTW outcomes. Workplace interventions, especially accommodations, appear to be more important for satisfactory RTW than differences in medical treatment. More attention to workplace factors is necessary to improve the long-term impact of CTS on work function.

**Keywords:** Disability prevention, Carpal tunnel syndrome, Prognosis of MSD.



## DYNAMICS OF WORK-RELATED MUSCULOSKELETAL DISORDERS (MSDS): LONG-TERM TRENDS AND LIFE COURSE APPROACH

### **Symposium Description**

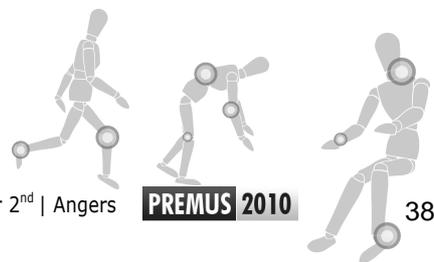
The aims of this session will be 1. to present time trends in musculoskeletal pain and its consequences among working age people, and 2. to present long-term effects of risk factors in early adulthood on work-related outcomes (unemployment, disability) in later adult life.

### **Symposium Author**

Dr. Helena Miranda

### **Authors linked to the symposium**

<b>Authors linked to the symposium</b>	<b>Name of their abstract</b>
LEJON O	Time trends in musculoskeletal pain in a working age population
STEENSTRA I	Changes in the incidence of occupational disability as a result of back and neck pain in The Netherlands and Ontario, Canada after legislative changes.
FRILANDER H	Musculoskeletal symptoms during young adulthood predict future unemployment. Results from a 30-year follow-up among Finnish conscripts
MIRANDA H	Do health behaviors, social exposures or musculoskeletal health before entering work life predict later sickness absence due to MSDs?
KRISTENSEN P.	Physical fitness in adolescence and musculoskeletal sickness absence 5-15 years later: cohort study of 227 201 male employees born in Norway 1967-1976



## TIME TRENDS OF MUSCULOSKELETAL PAIN IN A WORKING AGE POPULATION

LEIJON O., WAHLSTRÖM J., MULDER M.

*Department of Public Health Sciences, Division of Occupational and Environmental Medicine, Karolinska Institutet, Sweden*

### Aims:

To investigate time trends of neck-shoulder-arm pain, low back pain, concurrent neck-shoulder-arm and low back pain, neck-shoulder-arm pain and concurrent psychological distress, and low back pain and concurrent psychological distress [1, 2].

### Methods:

Every 4 years between 1990 and 2006, self-administered questionnaires were sent to random samples of the population in the County of Stockholm, Sweden (response rate 61–69%). All individuals aged 21–64 years in the five samples (n=1976–26,611) were included in the study.

### Results:

The prevalence of neck-shoulder-arm pain rose over a 16-year period, from 22.8 to 25.0% among women (prevalence rate ratio (PRR) 1.10) and from 12.8 to 15.4% among men (PRR 1.21). The prevalence of low back pain rose from 12.5 to 16.4% among women (PRR 1.31) and did not change among men (11.8 to 12.0%, PRR 1.02). Also the prevalence of concurrent neck-shoulder-arm pain and low back pain rose, from 8.4 to 10.8% among women (PRR 1.28) and from 5.3 to 6.6% among men (PRR 1.24). Figure 1 show that the prevalence of neck-shoulder-arm pain and concurrent psychological distress rose more substantially among women and men (PRR 1.91 and 2.18) as well as the prevalence of low back pain and concurrent psychological distress (PRR 2.23 and 1.82). All prevalences rose between 1990 and 2002, and decreased in 2006 compared to 2002.

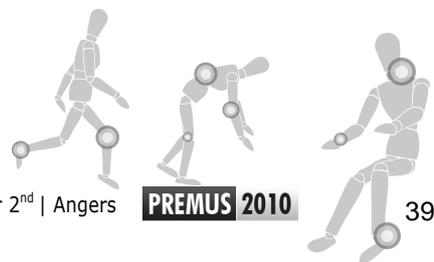
### Conclusion:

It is still too early to conclude that we have reached or passed the peak of the “epidemic” of musculoskeletal pain. There is a need for studies on the general population’s awareness and perception of pain and psychological distress, since this may have changed over time and, in turn, affected individuals’ willingness to report these symptoms.

**Keywords:** Epidemiology, Back, low back, Neck.

### References:

- Leijon O, Wahlström J, Mulder M. Prevalence of self-reported neck-shoulder-arm pain and concurrent low back pain pr psychological distress: time-trends in a general population, 1990–2006. *Spine* 2009;34:1863–8.
- Leijon O, Mulder M. Prevalence of low back pain and concurrent psychological distress over a 16-year period. *Occup Environ Med* 2009;66:137–9.



## CHANGES IN THE INCIDENCE OF OCCUPATIONAL DISABILITY AS A RESULT OF BACK AND NECK PAIN IN THE NETHERLANDS AND ONTARIO, CANADA AFTER LEGISLATIVE CHANGES.

STEENSTRA I.<sup>1,2</sup>, DAVILMAR A.<sup>1</sup>, HOGG-JOHNSON S.<sup>1,2</sup>, VERBEEK J.<sup>3</sup>

<sup>1</sup> Institute for Work & Health, Toronto, Ontario, Canada - <sup>2</sup> University of Toronto, Dalla Lana School of Public Health - <sup>3</sup> Center for Occupational Health, Finnish Institute for Occupational Health, Kuopio, Finland and. Faculty of Medicine of the University of Amsterdam

We will examine trends in the number of disability pensions after changes in work disability legislation in the Netherlands and Canada. We will compare results from Canada and The Netherlands to examine the influence of aging on disability pensions between two jurisdictions with similar age distributions.

In the Netherlands all workers are insured against loss of earnings due to disability. Disability is defined as the loss of earning capacity as a result of the inability to perform work tasks due to disease or infirmity. The benefit is granted after a disability evaluation, which includes a health examination by an insurance physician. The physician makes a diagnosis as a result of this examination or gathers additional information from treating physicians. Data on diagnosis of occupational disability as a result of low back pain according to age and gender was obtained from the Bureau of Statistics of the Industrial Insurance Administration Office for the period 1980-1985. Data for 1999-2006 was obtained from the National Institute of Social Insurance.

In Ontario, between 1990 and 2000, 65%–68% of the non-self-employed labour was covered by the WSIB. Data was obtained from the Workers Compensation Board of Ontario and its successor the Workplace Safety and Insurance Board. The time periods of interest are pre 1998 and post 1998, since the change in legislation took place in 1998.

Diagnostic codes used across timeframes and jurisdictions were converted to ICD-10 codes.

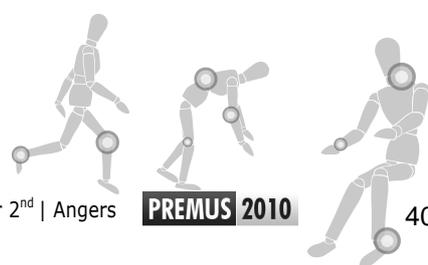
First analyses indicate that the Dutch changes in legislation have led to a dramatic decrease of new disability pensioners. The Canadian changes seem to have led to an increase of long duration claimants and an overall increase of the number of claimants.

**Keywords: Economics, Public policy, Back, low back.**

### References:

Verbeek JH. Arbeidsongeschiktheid op grond van aandoeningen van het bewegingsapparaat, een beschrijving (Occupational disability as a result of musculoskeletal disorders, a descriptive study. *T Soc Gezondheidsz* 1988;66:22-6.

Steenstra IA, Verbeek JH, Prinsze FJ, Knol DL. Changes in the incidence of occupational disability as a result of back and neck pain in the Netherlands. *BMC Public Health* 2006 Jul 18;6(1):190.



## MUSCULOSKELETAL SYMPTOMS DURING YOUNG ADULTHOOD PREDICT FUTURE UNEMPLOYMENT. RESULTS FROM A 30-YEAR FOLLOW-UP AMONG FINNISH CONSCRIPTS

<sup>1</sup> Finnish Institute of Occupational Health, Helsinki, Finland - <sup>2</sup> Centre for Military Medicine, Helsinki, Finland

### Aims:

Musculoskeletal symptoms and disorders (MSD's) are the leading reason for sick leaves and permanent work disability in many countries. Little is known to which extent musculoskeletal symptoms predict unemployment.

### Methods:

This prospective study is an extension of a large national cross-sectional health examination survey, the Health 2000 study carried out in 2000-2001 among a representative sample of the Finnish adults (total N = 9922). All men aged 18-50 years were further sampled from the Health 2000 study (n = 2675). Of these men, 86% (n=2298) had during 1967-2006 completed their compulsory 6 to 12-month long military service at the age of 19 years on average. Their military medical records were obtained from the Finnish Defence Forces' archives. Military service formed the baseline ('pre-work life') phase of the study with information on occupation, education, and health behaviours, measured body weight and height, and medical care visits due to musculoskeletal symptoms.

The Health 2000 Survey formed the follow-up phase of the study in which most participants were clinically examined by a physician using standardized diagnostic criteria for MSD's. Also, information on periods of unemployment during the preceding 5 years was collected with a face-to-face interview. Further, national social insurance registers will be utilized to collect information on unemployment in 1995-2006.

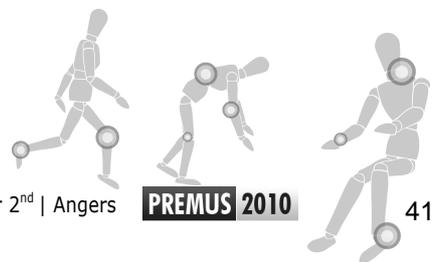
### Results:

The analyses and register data collection are still in progress. According to preliminary results, those conscripts who had several MSD-related medical visits during their military health service and particularly if the symptoms were widespread, had an increased risk of unemployment in the future. Further results will be presented and discussed in PREMUS 2010 congress at the 'Dynamics of work-related musculoskeletal disorders' -symposium.

### Conclusion:

Musculoskeletal symptoms in youth predict higher risk of unemployment later in life in men.

**Keywords:** Epidemiology, Early prevention, Other.



## **DO HEALTH BEHAVIOURS, SOCIAL EXPOSURES OR MUSCULOSKELETAL HEALTH BEFORE ENTERING WORK LIFE PREDICT LATER MUSCULOSKELETAL MORBIDITY OR SICKNESS ABSENCE?**

MIRANDA H., FRILANDER H., KAILA-KANGAS L., VIKARI-JUNTURA E.

**Finnish Institute of Occupational Health (FIOH), Finland**

### **Aims:**

Musculoskeletal symptoms and disorders (MSD's) are the leading reason for work disability in many countries, and at least in Finland, these disability rates have been increasing. Musculoskeletal symptoms often occur at an early age, before entering work life. At this age, many risk factor patterns, particularly those related to health behaviours, are also being formed. Hence, studies on the risk factors of future MSD-related work disability should preferably be extended beyond working populations also to young people about to enter labour market. The aim of this study is to identify risk and prognostic factors during childhood and young adulthood that predict later clinically diagnosed MSD and sickness absence from work, particularly due to MSD's.

### **Methods:**

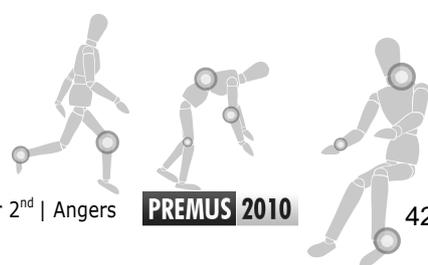
This prospective study is an extension of a large national cross-sectional health examination survey, the Health 2000 study carried out in 2000-2001 among a representative sample of the Finnish adults (total N = 9922). Men aged 18-50 years were further sampled from the Health 2000 study (n = 2675). Of these men, 86% (n=2298) had completed their compulsory 6 to 12-month long military service at the age of 19 years on average. Their military medical records were obtained from the Finnish Defence Forces' archives. Military service formed the baseline of the study with information on health behaviours (self-reported and objective fitness tests), measured body weight and height, and medical care visits due to musculoskeletal symptoms (from the military physicians' records).

The Health 2000 Survey formed the follow-up phase of the study in which most participants were clinically examined by a physician using standardized diagnostic criteria for MSD's. Also, information on total number of sick leave days during the preceding 12 months was collected with a face-to-face interview. Further, national social insurance registers will be utilized to collect information on sickness absence in 2001-2006. Information on parents' and own education and occupation was collected with the interview and on childhood adverse social events (parents' unemployment, sickness etc.) retrospectively with a questionnaire.

### **Results:**

The analyses and register data collection are still in progress. Results will be presented and discussed in PREMUS 2010 congress at the 'Dynamics of work-related musculoskeletal disorders' -symposium.

**Keywords:** Epidemiology, Early prevention, Other.



## PHYSICAL FITNESS IN ADOLESCENCE AND MUSCULOSKELETAL SICKNESS ABSENCE 5-15 YEARS LATER: COHORT STUDY OF 227,201 MALE EMPLOYEES BORN IN NORWAY 1967-1976

KRISTENSEN P., MEHLUM I.S., BJERKEDAL T.

*Institute of Health and Society, University of Oslo, Oslo, Norway*

### Aims:

We have shown that musculoskeletal sickness absence (MSD absence) in young adulthood was associated with parental education level (Kristensen et al. 2007). The aim of the present study was to estimate the influence of physical fitness at age 18 years on subsequent MSD absence among male Norwegian employees.

### Methods:

All 321 975 males born in 1967-1976 in Norway were followed up in several national registries and The Norwegian Armed Forces Personnel Data Base. Employees considered to be at risk of sickness absence on Jan 1st 2000 and having a measurement of physical fitness (N=227 201) were followed 2000-2003 regarding a first MSD absence (ICPC diagnosis L) exceeding 16 days. Fitness was measured at conscription (age 18 years) as poor (19.6%), medium (64.7%; reference) or high (15.7%). Covariates were year of birth, general ability and BMI at conscription, military duty conduct, and parental education level. Associations were estimated in Cox regression. Participants were censored out in case of sickness absence with other diagnoses, disability, emigration, or death.

### Results:

Totally, 26 061 (0.115) had a first absence with MSD diagnosis. Physical fitness was moderately associated with poor (HR 1.44, 95% CI 1.40 to 1.49) and high (HR 0.82, 0.79 to 0.85) fitness. Fitness associations were confounded by the covariates, with adjusted HR estimates of 1.14 (1.11 to 1.17) and 0.93 (0.89 to 0.96) for poor and high fitness, respectively. Associations examined in trajectories of own education level, family structure, and industry between conscription and start of follow-up suggest that the fitness effect could be explained by educational selection; family structure and industry had minor influence. The adjusted population attributable fraction (PAF) of physical fitness on MSD absence was 0.050 (95% CI 0.011 to 0.088), which was less than PAFs for general ability, BMI, military duty conduct, and parental education. Analysis in a subset (36.6%) with fitness level being based on lactate values showed a moderately higher fitness impact on absence (PAF 0.074, CI -0.013 to +0.155). However, the strength of confounding as well as the mediating role of own education was similar to those of the whole study population.

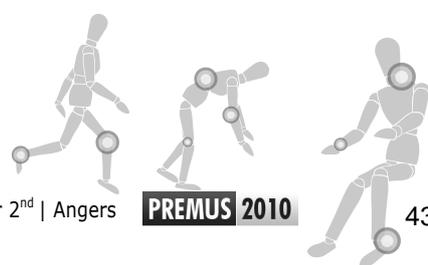
### Conclusion:

Physical fitness in adolescence had little impact on MSD absence 5-15 years later, and could be explained by a selective drift according to later educational attainment.

**Keywords:** Personal risk factors for MSD, Epidemiology, Social aspects of MSD.

### Reference:

Kristensen P, Bjerkedal T, Irgens LM. Early life determinants of musculoskeletal sickness absence in a cohort of Norwegians born in 1967-1976. *Soc Sci Med.* 2007; 64: 646-55.



## EVALUATION OF INTERVENTIONS DESIGNED TO PREVENT MSD: THEORIES AND STRATEGIES

### **Symposium Description**

Occupational health researchers are increasingly preoccupied with the outcomes and the cost-effectiveness of interventions designed to prevent musculoskeletal disorders. Evaluation of such important dimensions is becoming more frequent in our scientific community. Given that evaluative research as well as occupational health are multidisciplinary domains, a variety of methodological and theoretical frameworks are used to make a value judgement on such questions as well as on the relevance, the implementation, and the efficiency of interventions. Of course, there is no consensus on the best frameworks and methods to use, but perhaps some agreement on approaches could be established if there was a forum where researchers and practitioners could share their points of views and help to improve our knowledge of interventions. Without development and exchange of scientific knowledge we cannot expect to improve MSD prevention. Consequently, the objective of the symposium is to facilitate a dialogue amongst academics involved in evaluative research in order to improve our understanding and respect of our respective paradigms. The lectures will discuss the theories and methods used in different contexts to evaluate interventions designed to prevent MSD. We plan to answer the following question: How can we build and exchange scientific knowledge on interventions that succeed in reducing MSD in real work settings?

We will put the emphasis on the following aspects:

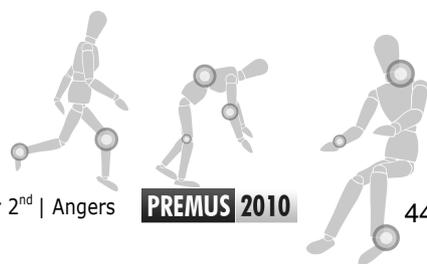
1. Randomised controlled trial is a design frequently used to verify if an intervention produces its expected outcomes. Given the problems that may occur with randomisation and the biases that may jeopardize the external validity of the inferences, what are the other designs available? What are their strength and limitations?
2. Most of the authors of papers published in scientific journals provide little information on the characteristics of the interventions under study, or of the context in which their research has been conducted. For example what does a “participative approach” or a “work analysis training” mean? Consequently, the usefulness of their results is difficult to appreciate. What type of information should be included in scientific papers devoted to evaluative studies in order to maximise their usefulness?

### **Symposium Author**

Prof. Fabien COUTAREL

### **Authors linked to the Name of their abstract symposium**

COUTAREL F.	How “intervention research” could contribute to knowledge on MSDs prevention?
WELLS R.	Evaluation of interventions designed to prevent MSD: what can we learn from successes and failures
DURAND M.J.	Lessons learned from evaluative research in the field of work rehabilitation
VAN DER BEEK A.J.	Randomization, what is it good for?
BERTHELETTE D.	How could we improve the generalizability of evaluation results of programs designed to prevent back pain?



## HOW "INTERVENTION RESEARCH" COULD CONTRIBUTE TO KNOWLEDGE ON MSDS PREVENTION?

COUTAREL F.

Clermont Université, Université Blaise Pascal, EA 4281, PAEDI, France.

### Aims:

In 2004, at Zurich PREMUS Congress, we present the results of an ergonomic intervention, demonstrating the possibility of achieving improvements in terms of working conditions and productivity. Only one question was asked: "did you have a control group?".

We wanted to discuss the benefits of alternative approaches to intervention by research when randomized controlled trial (RCT) is impossible to implement or too costly (Shadish and al., 2002).

### Methods:

We have reviewed scientific publications on this issue.

### Results:

Most of the studies based on RCT approach evaluate simple interventions that focus on one aspect of work situation, with a large number of workers. These workers are in very different work situations but their number can statistically compensate for these variabilities. We also know that MSDs are multifactorial diseases, so that effective prevention requires action on a variety of constraints. The intervention approaches needed are inevitably complex and involve changes of workstation, work organisation, and the actors themselves (training in job analysis, understanding of various issues related to design, knowledge of many other work situations and strategic issues for work situations concerned). They often involve a small number of workers. Understanding the specific contexts and different constraints is inconsistent with the possibility of identifying comparable workers for a statistical approach.

Intervention Research is a qualitative approach, based on an accurate description of the results, the process of intervention and its context. Monitoring of symptoms does not seem sufficient to assess the performance of the intervention. Future studies should help to clarify the nature of different indicators relevant to the work situation changes (workstation, work organisation, subjective experience of work). The description of the precise course of action is another important issue. In current publications, data are often very limited and does not allow readers to accurately assess the resources involved, which led to obtaining the results highlighted. Finally, the context of the intervention must not only be accurately described, but also categorised to enable those involved in prevention to assess the proximity or distance with their own contexts of action.

### Conclusion:

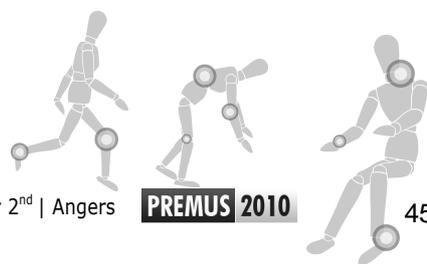
The "intervention research" orientation is essential for prevention since it is evaluating complex actions in specific contexts, corresponding to situations with which prevention specialists are struggling. The usefulness of scientific literature on intervention seems required several conditions. One intervention can contribute to knowledge if it is sufficiently described and if discussion can examine previous models of action (Yin, 1990).

**Keywords:** Work organization, Intervention studies, Intervention methods.

### References:

Shadish WR, Cook TD, Campbell DT. Experimental and Quasi-Experimental Designs for Generalized Causal Inference, Houghton Mifflin Company, 2002.

Yin R.K. Case Study Research. Design and Methods, Sage, 1990.



## EVALUATION OF INTERVENTIONS DESIGNED TO PREVENT MSD: WHAT CAN WE LEARN FROM SUCCESSES AND FAILURES

WELLS R.

*University of Waterloo, Ontario, Canada.*

### **Aims:**

Evaluations of participative ergonomics (PE) interventions have reported mixed results however, even for the successes, it is not clear what the intervention actually was, nor whether the contextual factors would mitigate against its successful transfer to other settings. The paper uses the findings from a recent multiple case study (Cole et al, 2010) to show how the combination of effects and process evaluation was critical to understanding the interventions.

### **Methods:**

Four participative ergonomics interventions to prevent MSD were performed using quasi-experimental designs (Cole et al, 2010). Ergonomic change teams were formed, trained and facilitated for intervention periods of 10-20 months. Qualitative methods were used for examining “how” and “why” questions, Implementation and a range of outcomes were assessed on cohorts of workers using questionnaires, observation and technical methods.

### **Results:**

The teams each introduced between 10 and 21 changes over 10-20 months of activity. A small number of effects on physical effort and pain were discernible. The outcome and process evaluations identified a combination of theory and practice failures, the influence of revolutionary and evolutionary changes, high and low capital cost settings, competing demands within the organization and a of lack of institutionalization as affecting the outcomes.

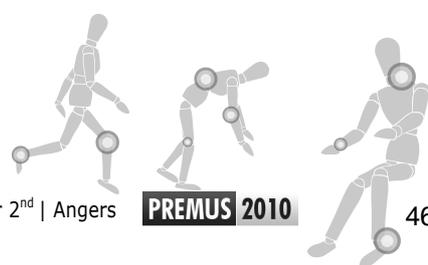
### **Conclusion:**

These interventions could be regarded as failures and perhaps not submitted nor accepted for publication. Labeling an intervention as a success or failure is not particularly helpful. The term “ergonomic intervention” when applied to the prevention of musculoskeletal disorders (MSD) covers a wide range of activities from evaluating the efficacy of pieces of equipment, policy and training to interventions of a programmatic nature such as participative ergonomics teams. For equipment interventions, randomized trials, a Mode 1 research paradigm, have been found useful. For programmatic interventions the importance of context increases. The programmatic interventions benefit greatly from a stock of interventions – often equipment - that have been shown to be effective under well-controlled and resourced settings. What is not clear is how these innovations are adapted to the specific local context and what activities, and by whom, help or hinder their actual implementation. A Mode 2 research paradigm may be more useful here. If the reasons for what occurred, or did not occur, are well understood, lessons for future interventions can be learned by practitioners, researchers and policy makers, and inform future interventions.

**Keywords:** Early prevention, Intervention studies, Intervention methods.

### **Reference:**

Cole D, Theberge N, Dixon S, Rivilis I, Neumann W. and Wells R. Reflecting on a program of participatory ergonomics interventions: a multiple case study. *Work* 2009; 34:161-178.



## LESSONS LEARNED FROM EVALUATIVE RESEARCH IN THE FIELD OF WORK REHABILITATION

DURAND M.J., BERTHELETTE D., LOISEL P.

Centre for action in work disability prevention and rehabilitation (CAPRIT) and Université de Sherbrooke, Longueuil, Canada; Université du Québec à Montréal, Montréal, Canada; University Health Network and University of Toronto, Toronto, Canada

### Aims:

Evaluative research in the field of work rehabilitation is fairly recent. This presentation will present lessons learned from three evaluative studies.

### Methods:

Evaluative studies were on (1) the development of the program theory of a progressive return-to-work program, (2) the implementation study of a collaborative program for low back pain patients (combined with a RCT), and (3) a multisite implementation of a work rehabilitation program at a provincial level.

### Results:

Several lessons can be learned from these studies. First, to improve the quality of service delivery to persons with work disability, it is essential to make explicit the underlying program theory, without which several activities could be replicated without effect or even with harmful effect. Program theory is a set of assumptions about the manner in which the program is related to the social benefits it is expected to produce and to the strategy and tactics to be adopted to achieve its goals and objectives (Chen, 2005). Second, negative results found in a RCT concluded that the program has no effect on outcomes. However, the concomitant implementation study showed that some components were inadequately or incompletely implemented, which hindered the program's desired impact. In program evaluation, this refers to a type III error, i.e., leading to a conclusion of program (un)effectiveness when in fact it was not implemented as planned (Dobson and Cook, 1980). Third, the implementation of a work rehabilitation program at a provincial level was prematurely aborted because of the high cost engendered by the clinical teams set in place. These costs were mainly due to the lack of referrals and thus, the high resources/services ratio. One lesson learned from this project is the importance of focusing on obtaining concerted action of all players and avoiding a top down approach during the implementation process.

### Conclusion:

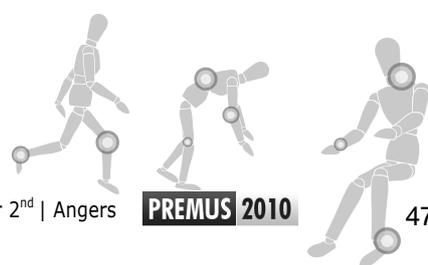
Evaluative research in the field of work rehabilitation provides complementary information to traditional study designs. It allows to improve intervention, facilitate program evaluation, and contributes to knowledge translation and exchange.

**Keywords:** Intervention studies, Return to work, Other.

### References:

Chen H-T. Practical program evaluation: assessing and improving planning, implementation and effectiveness. Thousand Oaks, CA: Sage Publication Inc.; 2005.

Dobson D, Cook TJ. Avoiding type III errors in program evaluation: results from a field experiment. Eval Program Planning. 1980;3(4):269-376.



## RANDOMIZATION, WHAT IS IT GOOD FOR?

VAN DER BEEK A.J.<sup>1,2</sup>

<sup>1</sup> Department of Public and Occupational Health, EMGO+ Institute for Health and Care Research, VU University Medical Centre, Amsterdam, The Netherlands – <sup>2</sup> Body@Work, Research Centre on Physical Activity, Work and Health TNO-VU/Umc, Amsterdam, The Netherlands.

### Aims:

Occupational health researchers are interested in the effectiveness of interventions designed to prevent musculoskeletal disorders (MSD). Randomised Controlled Trials (RCTs) are frequently used to verify if an intervention creates its expected preventive outcomes. However, randomisation is often considered to be difficult or even impossible in real working life. Therefore, several researchers have chosen other designs in the occupational setting. The aim of this paper is to discuss the strengths and limitations of study designs.

### Methods:

General epidemiological principles were summarised to shed light on methodological pros and cons of the RCT and designs other than the RCT. Problems that may occur with randomisation were identified on the basis of practical experiences.

### Results:

In an ideal study intervention group(s) and control group(s) differ on one aspect only: the studied intervention(s). Randomisation optimises the chance that the intervention and control groups are the same regarding all known and unknown factors that might influence the outcome measures of the study. Basically, five aspects can be mentioned regarding these factors: 1) history ((un)expected events and circumstances during study), 2) maturation (secular/temporal trend of outcomes), 3) testing (changes caused by assessments, or regression to the mean), 4) selection (study groups different), and 5) attrition (lost to follow-up different in study groups).

Randomisation within the same company can be unwise, because of the risk of contamination between intervention and control group. In such situations the CT can be the optimal study design. Managers in real working life often do not allow (R)CTs to take place in their company, since they want to treat all workers the same way.

Other types of study designs can be chosen: observational (e.g. cohort) or quasi-experimental studies (e.g. before-after measurement, with or without reference population). These study designs can offer valuable insights, but the earlier-mentioned influences may jeopardise internal validity of the results. Some of these influences can be controlled for in statistical analyses, but this is not always the case.

### Conclusion:

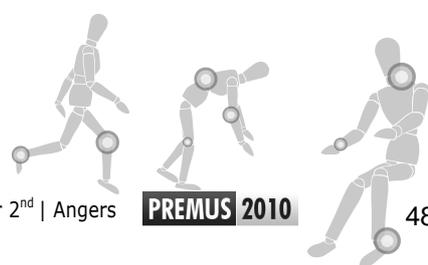
This paper discussed the strengths and limitations of several designs in intervention studies aiming at prevention of MSD. At PREMUS these issues will be illustrated with actual studies (Proper, 2004; Anema, 2004). Furthermore, some additional aspects will be introduced, such as cluster versus individual randomisation, difference between explanatory and pragmatic trials (efficacy and effectiveness, respectively), and pre-randomisation.

**Keywords:** Methods in epidemiology, Intervention studies, Public policy.

### References:

Anema JR, Cuelenaere B, Van der Beek AJ, Knol DL, De Vet HCW, Van Mechelen W. The effectiveness of ergonomic interventions on return-to-work after low back pain; a prospective two year cohort study in six countries on low back pain patients sicklisted 3-4 months. *Occup Environ Med.* 2004;61:289-94.

Proper KI, Van der Beek AJ, Hildebrandt VH, Twisk JWR, Van Mechelen W. Worksite health promotion using individual counselling and the effectiveness on sick leave; results of a randomised controlled trial. *Occup Environ Med.* 2004;61:275-9.



## HOW COULD WE IMPROVE THE GENERALIZABILITY OF EVALUATION RESULTS OF PROGRAMS DESIGNED TO PREVENT BACK PAIN?

BERTHELETTE D., LEDUC N., BILODEAU H., DURAND M.J.

1.Centre de liaison sur l'intervention et la prévention psychosociales and Department of Organization and Human Resources, Université du Québec à Montréal, Montréal; 2.Department of Health Administration, Université de Montréal, Montréal;3.Department

### Aims:

Primary back pain prevention programs that concentrate on worker training have been popular for several years. Many studies and systematic reviews have tried to evaluate their effectiveness. Most of them privileged epidemiological methods, more specifically randomised clinical trial. Other methods coming from disciplines such as evaluative research or ergonomics are described as methodologically weaker. Our objective is to discuss the scope and limits of epidemiology to evaluate the effectiveness of primary back pain prevention programs and to propose alternatives from the field of evaluative research.

### Methods:

We have reviewed scientific publications on this issue from 1980 to 2010.

### Results:

Most of the studies evaluate simple interventions that focus on training only or on training combined with making patient lifting equipment available in the workplace, whereas in theory, to be effective, a primary back pain prevention program must address all the risk factors for back pain present in the work environment, namely, the physical and biomechanical characteristics of work, the management of work environments and equipment and the psychosocial aspects of work. The likelihood of simple training programs that target only behavioural changes reducing the incidence of back pain is therefore low. This may partly explain why most of epidemiological studies on the ultimate outcomes of primary back pain prevention programs do not provide evidence of their effectiveness. Furthermore, epidemiological studies adopt the black box approach, in which the authors neglect to specify the underlying program theory (Chen, 1990). Without knowledge of such theory, it is difficult to ascertain the external validity and usefulness of the study's inferences.

### Conclusion:

Further research is needed in order to evaluate complex programs addressing all the risk factors for back pain present in the work environment. However, to prevent the occurrence of a Type III error, i.e. a bias consisting in erroneously concluding that a program is inefficient when the absence of effect is actually due to incomplete or inadequate program implementation (Shadish et al., 2002), the integrity of such complex programs must be appraised and ensured before their effectiveness is evaluated in real work settings. Observational evaluations are needed to evaluate complex programs and they must be taken into account in practical evidence-based guidelines. Without them, such guidelines would be biased, reflecting interventions that are easy to evaluate using epidemiological methods but that are not necessarily more efficient or are characterized by a high cost/benefit ratio (Des Jarlais et al., 2004).

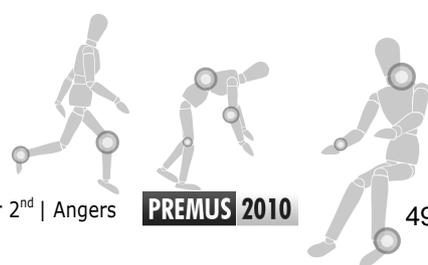
**Keywords:** Early prevention, Intervention studies, Back, low back.

### References:

Chen HT. Theory-Driven Evaluations. Newbury Park: Sage Publications, 1990.

Shadish WR, Cook TD, Campbell DT. Experimental and Quasi-Experimental Designs for Generalized Causal Inference, Houghton Mifflin Company, 2002.

Des Jarlais DC, Lyles C, Crepaz N. and the Trend Group. Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: The Trend statement. Am J Public Health. 2004;94(3): 361-366.



## GENDER, WORK ACTIVITY AND MSD: WHAT ARE THE IMPLICATIONS FOR INTERVENTION?

### **Symposium Description**

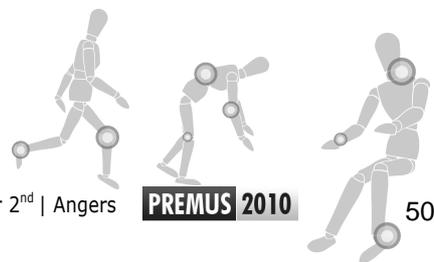
There is a growing consensus that men and women are not exposed to the same work conditions and that these differences can influence the development of musculoskeletal disorders. Consequently, in order to effectively prevent work-related musculoskeletal disorders (WMSD), it is important to take gender into account in ergonomic interventions. The objective of this symposium is to explore how gender-based ergonomic analysis of work activity can contribute to a greater understanding of the relationships between work and MSD and lead to innovations in ergonomic interventions to prevent work-related musculoskeletal disorders. The symposium will begin with reflections and reviews of the work of 2 francophone groups of researchers, one in France, the other in Quebec, both associated with the Technical Committee on Gender and Work of the International Ergonomics Association (IEA); Sandrine Caroly and Marie Laberge will each provide an overview of the studies carried out by researchers of these 2 groups and discuss the research questions and challenges associated with gender-based analysis of work activity and the potential implications for ergonomic interventions. Then Marie Authier will present a more detailed example of a study using gender-based ergonomic analysis of work activity in the context of MSD prevention. This will be followed by a round table with 5 researchers from five different countries who will comment and initiate exchanges with participants on the potential contributions and the methodological and practical challenges of gender-based ergonomic intervention studies to prevent MSD. This symposium is organised in collaboration with the Francophone Group of the Technical Committee on Gender and Work of the International Ergonomics Committee (IEA). This committee promotes the advancement of knowledge on the interactions between gender, sex and ergonomics. The Chair of the symposium will be Susan Stock.

### **Symposium Author**

Mrs. Marie LABERGE

### **Authors linked to the Name of their abstract symposium**

AUTHIER M.	Women in manual materials handling: a complex question
LABERGE M.	Results and reflections on gender based ergonomic intervention from the Quebec working group of the IEA technical committee on gender and work (QTC)
CAROLY S.	Emergence of the theme of gender in ergonomics: overview of the activities and reflections of the European francophone network of the IEA technical committee on gender and work



## WOMEN IN MANUAL MATERIALS HANDLING: A COMPLEX QUESTION

AUTHIER M.

*Département de médecine, Université de Montréal, Montréal, CANADA*

### **Aims:**

An ergonomic study was conducted among handlers working in a warehouse with the aim of evaluating the impact of work restructuring. A time-and-motion study approach led to a modification in the way of establishing the standards expected from the workers. Instead of a daily standard based on a thousand boxes unloaded during the work shift, the workers have now a standard time allowed to unload each container, based on its content. Moreover, a prescribed work method has been imposed on the workers with the aim of reducing all unproductive periods (eg. moving around, informal rest breaks). At the request of the union, particular attention was given to the activity of the women in order to examine whether the new standards were too high for them.

### **Methods:**

Observations were done with 23 men and 5 women in varying work situations (e.g. type of containers, type of merchandise). Moreover, 30-min interviews have been conducted with 10 men and 5 women in order to learn about their difficulties, their view of the impact of restructuring on their work activity and the impact on their well-being.

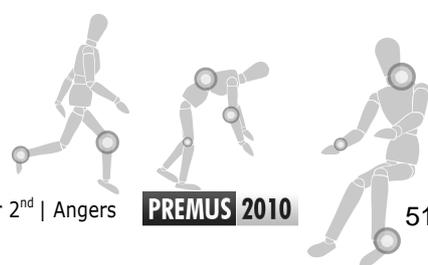
### **Results:**

Handlers unload containers filled with boxes of different shapes and weights and stack them onto a pallet. The cumulative average daily weight handled is 17,800 kg. The average weight of the boxes is 16 kg, with 7% over 20 kg. Both greatly exceed current recommendations for manual material handling for women. The observations showed that women have developed work methods that differ from those of men. Their techniques require less force and biomechanical strain and allow them to get through their work day. However, these work methods take more time, which is disadvantageous if the prescribed work organization is based on standardized times per operation. Women have reported that the workload is excessive but they say that they can meet the task requirements. Women differ amongst themselves in opinions regarding the necessity to adopt gender-specific measures in order to help women maintain employment in non-traditional jobs.

### **Conclusion:**

This intervention raises the delicate question of gender-based recommendations in a manual handling job. From an ergonomic and theoretical point of view, measures should be implemented in order to make tasks accessible for women of average size and strength. However, the question gets more complex when taking into account other dimensions of the real-life situation such as the integration of women into a male environment and the social relations between men and women in the enterprise.

**Keywords:** Work organization, Intervention studies, Gender differences.



## RESULTS AND REFLECTIONS ON GENDER BASED ERGONOMIC INTERVENTION FROM THE QUEBEC WORKING GROUP OF THE IEA TECHNICAL COMMITTEE ON GENDER AND WORK (QTC)

LABERGE M., MESSING K.

*Interdisciplinary Centre for the Study of Biology, Health, Society and Environment (CINBIOSE), University of Quebec at Montreal (UQAM), Montreal (Quebec), Canada*

### Aims:

Men and women do not hold the same jobs and do not have the same working conditions. This situation leads to different risk factors and thus to different WMSD (1, 2). Some ergonomists have begun to carry out interventions with a gender-sensitive approach to better understand how sex and gender interact with work activity, its determinants and its consequences (3). In 2006, the International Ergonomics Association (IEA) created a new technical committee aiming to promote research and information sharing about gender and work issues. This communication will present an overview of the gender-based ergonomic intervention research and reflections carried out by the Quebec Working Group of this technical committee (QTC) and some suggestions for future research orientations.

### Methods:

The QTC has held three workshops so far (four by the time of the PREMUS conference), structured around interdisciplinary presentations and discussions. The agendas, minutes and other notes have been analyzed in order to degage 1) major results and issues exposed by presenters (highlights) 2) major preoccupations of participants (discussion) and 3) needs for future development.

### Results:

Fifty researchers and practitioners, primarily ergonomists, participated in at least one of the workshops. Invited communications, whose subjects were chosen by the participants, covered areas of basic biology, methodology, law, and ethics relating to the interactions between sex, gender, work activity, ergonomic interventions and health. Experts presented on such diverse topics as gender and MSDs in contemporary dance, gender and workers' compensation law, gender and rehabilitation from MSDs, etc. Three themes or questions inspired most of the discussions: biological male-female differences and their implications for job adaptation; gender, family roles and the adaptation of work schedules; difficulties in treating gender questions during interventions.

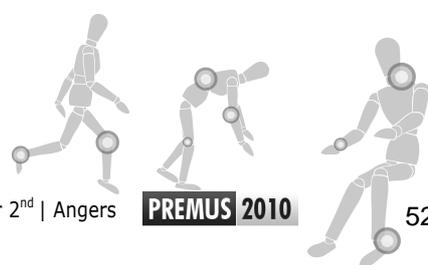
### Conclusion:

The QTC has so far stimulated interest and reflection on gender and ergonomics and is proving relevant to research and practice in ergonomics, promoting consideration of gender in the comprehension of exposure to risk factors, of occupational injuries and illnesses and of prevention. Further research should be devoted to intervention guidelines, gender-adapted ergonomic standards, gender-fair workers' compensation and rehabilitation practices and formal strategies to conciliate family role and work. Central preoccupations are: How should ergonomists address gender during research and intervention? Are the obstacles and facilitating factors in ergonomic interventions gendered? What are the methodologic challenges in measuring exposure and in evaluating interventions that will result in gender-sensitive practice?

**Keywords:** Intervention studies, Intervention methods, Gender differences.

### References:

Messing K, Tissot F, Stock S. Should studies of risk factors for MSDs be stratified by gender? Lessons from analyses of musculoskeletal disorders among respondents to the 1998 Québec Health Survey. *Scand J of Work Environ Health*. 2009;35(2):96-112.  
Punnett L, Herbert R. Work-related musculoskeletal disorders : Is there a gender differential, and if so, what does it mean? In Goldman M B; Hatch M C editors. *Women and health*. New York: Academic Press; 2000. p 474-492.  
Caroly S, Teiger C. Genre, sexe, travail et santé - la difficile émergence de cette problématique en ergonomie. *Archives des Maladies Professionnelles et de L'Environnement*, 2008;9(2):117-119.



## **EMERGENCE OF THE THEME OF GENDER IN ERGONOMICS: OVERVIEW OF THE ACTIVITIES AND REFLECTIONS OF THE EUROPEAN FRANCOPHONE NETWORK OF THE IEA TECHNICAL COMMITTEE ON GENDER AND WORK**

CAROLY S.

*Laboratory PACTE, University of Grenoble, France*

### **Aims:**

The objective of this presentation is to present reflections and activities of the network on gender and work of European section. The goal of our network is to promote the theme of gender and work among ergonomists and more generally occupational health actors. We are convinced that the gender perspective is an effective way of rethinking our models and our methodologies of intervention in ergonomics. Gender aspects were not always specified in the mandates for our interventions, but we were confronted with it, in particular during interventions relating to the prevention of MSD.

### **Methods:**

The network of researchers and practitioners in ergonomic and work psychology was created at the SELF 2006 congress, associated IEA technical committee Gender and Work. Since three years with seminars based on the exploration of our research projects and of published research, our network participates in scientific events during different national and international congresses of ergonomics. It also contributes to putting the gender perspective on the agenda through publications in scientific journal.

### **Results:**

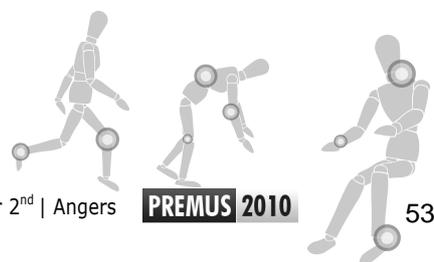
The relations between gender and design and between gender and work/life balance concern the relation to risk and the division of task according to gender:

- different factors of exposure according to gender which can generate MSD risks are ignored or underestimated by the actors in workplaces (in particular the allocation of tasks differentiated according to gender in formally identical posts). Many studies do not even control for the variable sex
- the processes of declaration and the criteria for the declaration of MSD don't recognize the women's health difficulties. The transformation of work situations and the design of work stations should take more into account the anthropometric characteristics of women and men and their activities
- MSD risk factors related to extraprofessional activities evoked by the actors in workplaces are very stereotyped according to gender.

### **Conclusion:**

The distinction between gender and sex is important in activity analyze. The model of activity must continue to be enriched by concept of regulation and collective activity. The possibility of developing coherence between the two spheres of activity (domestic, professional) could develop our models of activity and the construction of health. The contribution of ergonomics concern workplaces of men and women are present and collective activity. The methodologies for interviews, questionnaires and observation of activity should be improved in order to be able to obtain data on MSD differentiated according to the gender.

**Keywords:** Work organization, Intervention studies, Gender differences.



## **ROUNDTABLE ON GENDER-BASED ERGONOMIC INTERVENTION TO PREVENT MSD: ISSUES AND IMPLICATIONS FOR IMPLEMENTING CHANGES IN THE WORKPLACE**

**Chair:** Marianne De Troyer, Labour Sociologist, Ergonomist, Université Libre de Bruxelles (Belgium)

**Aim of the Roundtable:** Exchange and debate on issues posed by the implementation of changes inherent to the interventions incorporating gender-dimension.

On the basis of an MSD explanatory model (Vezina: 2001) focused on workers' activities, which includes both a comprehensive understanding of work situations and details of the activity, the identification of risk factors and their determinants. We invite the panel members to attempt to answer the following questions:

- How should one adapt ergonomic interventions to prevent MSD in order to adequately address gender issues?
- In an ergonomic intervention focused on gender-related risks, what type of changes are possible and what should we be aiming for?
- What are the obstacles and facilitating factors in ergonomic interventions focused on gender-related risks?
- What are the methodologic challenges in measuring exposure and in evaluating interventions that address gender issues?
- How should one adapt ergonomic interventions to prevent MSD in order to adequately address gender issues?
- In an ergonomic intervention focused on gender-related risks, what type of changes are possible and what should we be aiming for?

We are, however, aware that each explanatory model has its limits and that the diversity of populations (changes according to age, gender, experience, ethnicity, sector of activity, the activity itself, etc.) must be taken into account even if it is difficult to allow for those differences and avoid statistical bias. In addition, we apply the MSD's more strategic approaches, in the form of inherently participatory, integrated and multidisciplinary ergonomics in order to develop a production system that is sustainable from the human perspective in particular.

To stimulate the discussion, each panel member will speak for five minutes and will address one or two of the questions mentioned above in the context of the research he/she has done.

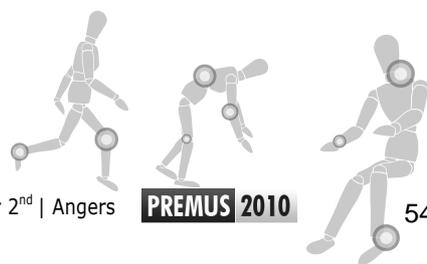
The panel members' remarks should therefore be in summary form.

### **Panelists:**

- Nicole Vézina, University of Quebec in Montréal, Canada.
- Debora Miriam Raab Glina, University of Sao Paulo, Brazil.
- Ola Leijon, Karolinska Institute, Sweden.
- Ghislaine Doniol-Shaw, National Center for Scientific Research, University of Paris-Est, France.

**Roundtable:** Each panelist will speak for 5 minutes addressing one or two of the following questions.

The panel will be followed by 20 minutes of exchanges with the audience and the panelists addressing these questions.



## **HEALTH AND SAFETY IN THE CONSTRUCTION INDUSTRY - PART 1: WORK DEMANDS AND RELATED HEALTH PROBLEMS**

### ***Symposium Description***

The construction industry is a large economic sector in all countries, accounting for seven to 12% of employment in industrialized countries. In the construction industry, musculoskeletal disorders (MSDs) are worldwide the primary reason for sickness absence and disability, being strongly associated with heavy work demands. Besides, it is also a very dangerous industry and accounts for around 20-30% of all serious occupational injuries of the musculoskeletal system.

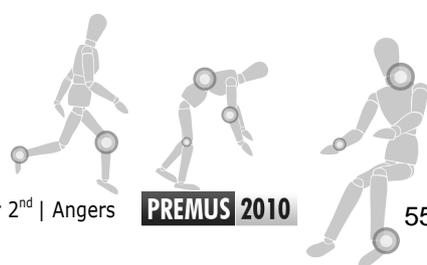
The aim of the special session Health and safety in the construction industry- Part 1: work demands and related health problems is to provide an overview on recent research in relation to health and safety issues in the field of the construction industry. The following aspects will be addressed: relationships between work demands and health or safety effects and exposure measurements.

### ***Symposium Author***

Dr. Vincent GOUTTEBARGE

### ***Authors linked to the Name of their abstract symposium***

BOSCHMAN J.	Physical demands and musculoskeletal health for bricklayers and construction supervisors – a systematic review
KIRKESKOV L.	Exposure to kneeling work tasks and knee disorders in floor layers
LIPSCOMB H.	Factors associated with delayed return to work after back injury among residential union carpenters
GOUTTEBARGE V.	Specific job demands in the construction industry for a pre-employment medical examination
EVANOFF B.	Work exposures and carpal tunnel syndrome among construction workers



## **PHYSICAL DEMANDS AND MUSCULOSKELETAL HEALTH FOR BRICKLAYERS AND CONSTRUCTION SUPERVISORS – A SYSTEMATIC REVIEW**

BOSCHMAN J.S., VAN DER MOLEN H.F., SLUITER J.K., FRINGS-DRESEN M.H.W.

*Academic Medical Center, University of Amsterdam, Department: Coronel Institute of Occupational Health, Amsterdam, the Netherlands*

### **Aims:**

The objective of this review was to gain insight into the physical demands and musculoskeletal health of two occupations in the construction industry, bricklayers and supervisors, as first step in designing a job-specific workers' health surveillance (WHS) for construction workers.

### **Methods:**

An electronic systematic literature search was performed in the databases MEDLINE, EMBASE, PsycINFO, HSELINE, NIOSHTIC-2 and Picarta up to December 2008. Four inclusion criteria were applied: 1) written in English, German or Dutch; 2) the study population concerns bricklayers or construction supervisors; 3) bricklayers or construction supervisors represent more than 50% of the population; 4) exposures or health effects were measured. Quality of study sample, exposure measurements, outcome, analysis and data presentation was assessed. Physical demands were categorized into energetic, biomechanical and environmental demands. The intensity, duration and frequency of the physical exposures were compared to existing regulations and professional guidelines. Evidence on health effects was interpreted as 'consistent', 'limited', 'conflicting' or 'no evidence for a relationship'. The direction of consistent and limited evidence was interpreted as 'favorable for health' or 'unfavorable for health'.

### **Results:**

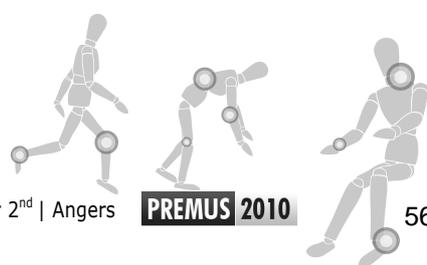
In total, 11 studies regarding biomechanical or energetic demands and 13 studies regarding musculoskeletal health effects have been found for bricklayers. Evidence is found for high energetic load (exceeding 25% heart rate reserve), high load on the lower back (exceeding the NIOSH-threshold value of 3.4 kN), highly repetitive force exertions of the upper extremities (by handling up to 262 bricks per hour) and frequent bending (up to 130 times per hour) with trunk flexion exceeding 60 degrees. Bricklayers are at increased risk for complaints or diseases of the low back and to a lesser extent to other body regions of neck, shoulder, elbow, wrist, hand, upper back, hip and knee.

For construction supervisors one single publication on biomechanical demands and four regarding musculoskeletal health effects have been found. Among construction supervisors are walking and standing common physically demanding activities but not exceeding professional guidelines. Limited evidence was found for an increased risk of musculoskeletal complaints of neck, shoulder, elbow, wrist/hand, upper back, lower back, hip, knee, ankle and foot.

### **Conclusion:**

In conclusion, for bricklayers evidence was found for high physical demands that exceed existing professional guidelines. Both professions, bricklayers and construction supervisors, have increased risk of musculoskeletal complaints.

**Keywords:** Construction, Other.



## **EXPOSURE TO KNEELING WORK TASKS AND KNEE DISORDERS IN FLOOR LAYERS**

KIRKESKOV L., RYTTER S.

*Dept of Occup Environ Medicine, University Hospital, Bispebjerg, Denmark*

### **Aims:**

To quantify the proportion of kneeling work activities among floor layers, and to evaluate the association between floor layers work and the prevalence of meniscal tears, and bursitis.

### **Methods:**

Thirty-three floor layers were videotaped discontinuously, in total 618 minutes, and four floor layers were videotaped continuously for a whole working day, in total 1668 minutes. External knee forces were measured in five different kneeling working positions in ten floor layers using Computer Dynography.

Magnetic resonance imaging (MRI) of both knees was conducted in 92 male floor layers and 49 male graphic designers (referents). The presence of degenerative meniscal tears of the lateral and medial menisci and bursitis in bursae around the knee were assessed in both knees. The Odds ratio (OR) of meniscal lesions and bursitis was determined in floor layers compared to graphic designers using logistic regression models and the results were adjusted for age, body mass index, and knee straining sports activities.

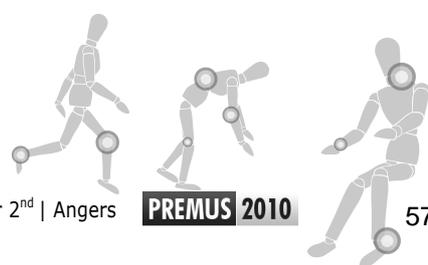
### **Results:**

Floor layers spent in average 41-65% of time in knee straining work positions and kneeling work task caused external knee forces up till 3.5 times body weight. The pressure was in our study especially high when crawling and gluing and these work tasks constitute a substantial amount of the work day. Degenerative meniscal tears in the medial meniscus were predominantly bilateral and significantly more prevalent among floor layers compared to graphic designers. The frequency of meniscal lesions did not increase with seniority in the occupation. Bursitis, not only in the infrapatellar bursa, but also in many of the other bursae was significantly more prevalent in floor layers compared to the referents.

### **Conclusion:**

Floor layers are one of the occupations with the highest percentage of kneeling work tasks. We do not know if there is a causal association between the external pressure and development of knee disorders, but it seems plausible that a combination of extreme flexion in the knee joint, microtraumas caused by frequent kneeling, and a high external pressure may cause knee disorders. The frequency of meniscal lesions did not, in this study, increase with anciennity in the occupation, which may be due to few participants in the study group. Identification of bursitis in many bursae, including the posterior part of the knee joint indicate that bursitis may not only be caused by direct pressure, but may also be caused by other intraarticular factors.

**Keywords:** Postures, physical exposure, Construction, Epidemiology



## **FACTORS ASSOCIATED WITH DELAYED RETURN TO WORK AFTER BACK INJURY AMONG RESIDENTIAL UNION CARPENTERS**

LIPSCOMB H.J., MIRKA G.A., NOLAN J., PATTERSON D., DEMENT J.M.

*Duke University, Durham, N.C., USA*

### **Aims:**

Data collected at the time of injury in an active injury surveillance program were used to explore factors associated with prolonged time away from work (30+ days) following back injury among union carpenters employed in residential construction.

### **Methods:**

Detailed data were collected from injured carpenters at the time of back injury including information on activity at the time of injury, past work history, as well as prior history of back pain and associated medical care. Data collection was through interviews conducted by journeymen carpenters on the research team using a standard data collection tool. Interviewers queried injured workers to obtain detail about circumstances surrounding the injury event. Injured workers were then followed forward in time to identify the period of time away from work following their injury. The experience of cases, defined as those with more than 30 days of lost work time, were compared to those of controls with more rapid return to work. Data collected on the activity at the time of injury were used to estimate acute spinal stress as measured by the NIOSH Lifting Index (LI), compression, sagittal and lateral moment, and percentage of high risk group membership using Continuous Assessment of Back Stress (CABS) methodology.

### **Results:**

Seventy-six (n=76) back injuries were investigated; 8.4% (n=14) resulted in 30+ lost work days. Prolonged time lost was more likely to follow acute events such as falls and being struck; 75% of manual handling tasks involved a NIOSH Lifting Index >3 and over half had LI > 5. A greater proportion of individuals with delayed return handled loads that were unexpected and were working in awkward posture; lifting index was more likely to exceed 5, they had higher compression and sagittal moment, and more had 75% probability of high risk group membership.

### **Conclusion:**

These analyses of data from active surveillance using a hybrid case-control design provide clear evidence of very significant spinal loads imposed by residential carpentry tasks and high risk for severe back injury associated with falls and being struck (particularly when handling very heavy loads such as framed walls), as well as overexertion events with high spinal load measures. Delayed return to work was associated with young age and less tenure; this is not what would be expected from cumulative stress. The fact that fewer of the severely injured were working alone likely reflects the very heavy nature of the work they were doing.

**Keywords:** Construction, Epidemiology, Return to work.

### **References:**

Mirka GA, Kelaher DP, Nay DT, Lawrence BM. Continuous assessment of back stress (CABS): a new method to quantify low-back stress in jobs with variable biomechanical demands. *Human Factors* 2000 Summer 42(2): 209-225.



## **SPECIFIC JOB DEMANDS IN THE CONSTRUCTION INDUSTRY FOR A PRE-EMPLOYMENT MEDICAL EXAMINATION**

GOUTTEBARGE V., VAN DER MOLEN H.F., SLUITER J.K., FRINGS-DRESEN M.H.W.

*Academic Medical Center, Department: Coronel Institute of Occupational Health, Amsterdam, the Netherlands*

### **Aims:**

Construction workers are highly exposed to many high work demands. Among preventive measures, pre-employment medical examinations (PE-ME) are aimed to protect prospective employee from work-related diseases and secure their ability to work during their employment. The Dutch legislation requests that PE-ME focuses only on specific job demands, demands being not preventable with state of the art ergonomics knowledge and that may overburden the bodily capacities, safety or health of workers. The aim of this study was to identify the specific job demands of the construction industry.

### **Methods:**

First, a systematic literature review through international literature from 1993 to 2009 was conducted. Our literature search involved several databases (Medline, Embase, OSH Update en PsycINFO) in which key words (construction work; work demands; health effects) and synonyms were sought in titles, abstract and/or full text. Inclusion criteria were used to select relevant articles (for instance, exposure measured in terms of duration, intensity and/or frequency) and data extraction was made in standardized tables. Second, an expert meeting was organized among 22 experts of the Dutch construction industry in order to validate the specific job demands obtained through our systematic review. In addition, possible still missing specific job demands could be assigned by the experts through a discussion forum and be successively validated. Using an electronic audience response system, a specific job demand was considered to be validated when at least two-third (66%) of the experts voted favorably.

### **Results:**

A total of 8802 studies were identified from the various databases searched. After assessing the inclusion criteria on titles, abstracts and full-texts, 89 studies were eligible for data extraction, resulting in 18 specific job demands. All 18 demands were validated by the experts. The discussion forum within experts delivered 24 additional specific job demands, from which nine did not passed the criterion for validation (66% or more). Then, 33 specific job demands for the Dutch construction industry were identified: 15 from physical nature such as standing and squatting, five from mental/psychological nature such as alertness and working in team, and 13 due to working conditions such as dust and weather conditions.

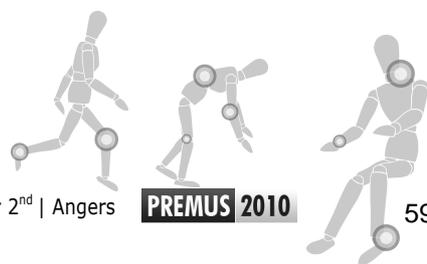
### **Conclusion:**

Conformingly the Dutch legislation, the 33 specific job demands validated thought Dutch construction experts could be subject to assessment in a PE-ME in order to reveal any medical condition that might put a prospective employee at an increased risk for him- or herself, or others.

**Keywords:** Postures, physical exposure, Construction

### **References:**

- de Kort W, van Dijk F. Preventive effectiveness of pre-employment medical assessments. *Occup Environ Med.* 1997;54:1-6.  
Sobeih T, Salem O, Genaidy A et al. Psychosocial factors and musculoskeletal disorders in the construction industry. *J. Constr. Engrg. and Mgmt.* 2009;135:267-277.  
van der Molen H, Veenstra S, Sluiter J, Frings-Dresen M. World at work: bricklayers and bricklayer's assistants. *Occup Environ Med.* 2004;61:89-93.



## WORK EXPOSURES AND CARPAL TUNNEL SYNDROME AMONG CONSTRUCTION WORKERS

DALE A.M., JAEGER L.A., EVANOFF B.

Division of General Medical Sciences, Washington University School of Medicine, St. Louis, Missouri, USA - Interventions LLC, Defiance, Missouri, USA

### Aims:

To evaluate the prevalence of carpal tunnel syndrome and associated physical work exposures among construction workers compared to other work types.

### Methods:

A cohort of 1107 newly-hired workers from several industries received nerve conduction testing of the hands at baseline and 3 years, and completed repeated surveys to record physical work exposures (lifting/carrying, hand gripping, finger pinching, wrist bending, forearm rotation, vibratory hand tool use, and repetitive movements), and hand symptoms on a hand diagram. A subset of workers received ratings for observed physical exposures of hand force, hand activity level, and wrist postures using videotaped samples of work tasks. Analysis was restricted to workers employed in the same job for 3 years (n=411). Multivariate logistic regression analysis evaluated job category (construction workers versus other industries) to cases with abnormal median neuropathy and with CTS (symptoms plus median neuropathy). Differences in self-reported and observed physical work exposures between work groups were evaluated using t-tests and ANOVA.

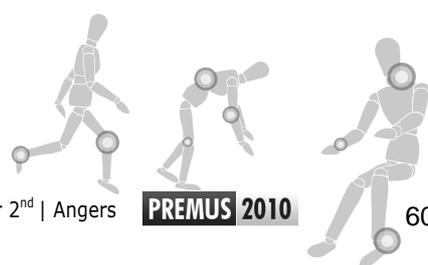
### Results:

Of 411 subjects, there were few cases of CTS (n=21) but higher frequency of median neuropathy (n=117; 18.1%) at 3 years. Job distribution was 256 (62%) construction workers (carpenters, floor layers, or sheet metal workers) and 155 (38%) workers from other industries (clerical, computer workers, food service, housekeeping, laboratory, and health technicians). Construction workers were younger (26 versus 38 years,  $p<0.01$ ), leaner (BMI: 26.7 versus 30.3,  $p<0.01$ ), and male (100% versus 32%,  $p<0.01$ ) compared to the other workers. Construction workers were two times more likely to have median neuropathy than other workers (OR= 2.1, 95% CI: 1.2, 3.8) after controlling for age and BMI. Construction physical exposures had higher level of peak hand force (5.6 versus 3.0,  $p<0.01$ ), hand activity level (4.1 versus 3.0,  $p<0.01$ ) on 0 to 10 (highest level) rating scales, and ACGIH HAL-TLV (0.96 versus 0.44,  $p<0.01$ ). All self-reported exposures had higher mean exposures for the construction group.

### Conclusion:

Construction workers have significantly higher levels of work exposures and greater frequency of abnormal median neuropathy compared to workers in several other industries. Numerous barriers exist to the implementation of recognized methods to reduce physical exposures in construction in the United States; continued efforts are required to reduce the burden of injury in this high-risk industry.

**Keywords:** Construction, Exposure measurement methods, Carpal tunnel syndrome



## HEALTH AND SAFETY IN THE CONSTRUCTION INDUSTRY- PART 2: INTERVENTION STUDIES

### **Symposium Description**

The construction industry is a large economic sector in all countries, accounting for seven to 12% of employment in industrialized countries. In the construction industry, musculoskeletal disorders (MSDs) are worldwide the primary reason for sickness absence and disability, being strongly associated with heavy work demands. The development and adoption of interventions and best safety and health practices in the construction industry should be a focus of interest in order to reduce work demands and the incidence of occupational diseases i.e. injuries.

The aim of the special session Health and safety in the construction industry- Part 2: intervention studies is to stimulate the exchange of ideas and experiences between researchers on recent best practices and intervention researches in relation to health and safety issues in the construction industry. The focus of this special session will be interventions measures applied in the construction industry in order to prevent or reduce the incidence of occupational MSDs.

### **Symposium Author**

Dr. Vincent GOUTTEBARGE

### **Authors linked to the Name of their abstract symposium**

OUDE HENGEL K.	A health promotion program at the workplace for construction workers: a feasibility evaluation within a randomized controlled trial
REMPEL D.	An intervention for overhead drilling to reduce upper extremity musculoskeletal risk factors
VAN DER MOLEN H.	Impact of ergonomic measures on productivity, task demands and workload – examples of two construction jobs.
WELCH L.	Masonry ergonomics best practices
LAHIRI S.	Economic evaluation of interventions to reduce ergonomic injuries in construction



## A HEALTH PROMOTION PROGRAM AT THE WORKPLACE FOR CONSTRUCTION WORKERS: A FEASIBILITY EVALUATION WITHIN A RANDOMIZED CONTROLLED TRIAL

OUDE HENGEL K.M., JOLING C.I., PROPER K.I., BONGERS P.M.

*Body@Work, Research Center Physical Activity, Work and Health, TNO-VUmc, The Netherlands*

### Aims:

To promote the work ability of construction workers, a health promotion program (HPP) focusing on their individual capacities as well as the work environment was developed. This program was developed using the Intervention Mapping approach and is evaluated by means of both a process and an effect evaluation. The current study focuses on the process evaluation and aims to describe (1) the reach of the program, (2) the initial expectations and satisfaction and (3) the intention to implement the intervention program in the future

### Methods:

The process evaluation was carried out within a randomized controlled trial (RCT) on the effectiveness of a HPP for construction workers. The intervention consists of three components: (1) an individual visit of a physical therapist to lower the physical workload, (2) a Rest-Break tool to improve the balance between work and recovery, and (3) an empowerment training to increase the influence at the worksite. Data were collected from the employees and their supervisors by means of questionnaires. In addition to this, data were collected from all stakeholders by means of interviews and group discussions in order to conduct a more in-depth investigation of the working mechanisms of the intervention.

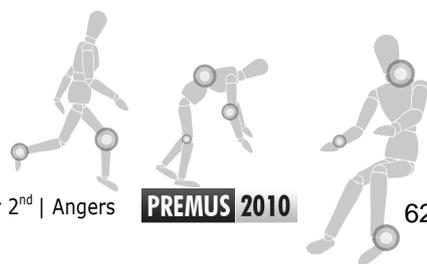
### Results:

From the more than 150 companies which were approached, the top management of five construction companies committed themselves to participate. Supervisors as well as employees were satisfied with the overall concept of the multidimensional intervention program (7 (median) on a ten-point scale ranging from 1-10). Employees and supervisors mostly appreciated the physical component (i.e. physical therapist intervention at the worksite), and the empowerment component of the program. The participating employers expressed positive intentions to further implement the intervention program in the future. This abstract contains only preliminary results of the questionnaires. More results are available in June 2010.

### Conclusion:

The present study took a participative approach (Intervention Mapping) and showed that this had a positive effect on the feasibility of the resulting intervention program. In developing the actual content of the intervention and the intervention strategy, much attention was paid to the needs of the target group, the way in which they could be motivated to participate, as well as to practical issues of them being able to take part in such a program whilst at work at building sites. The preliminary results of the process evaluation indicate that we have reached these goals. The HPP thus seems promising for future implementation.

**Keywords:** Construction, Intervention studies, Other.



## AN INTERVENTION FOR OVERHEAD DRILLING TO REDUCE UPPER EXTREMITY MUSCULOSKELETAL RISK FACTORS

REMPEL D.M., BARR A., STAR D., JANOWITZ I.

*Division of Occupational and Environmental Medicine, University of California, San Francisco, USA*

### Aims:

One of the most physically demanding tasks that commercial construction workers perform is overhead drilling holes into concrete or metal ceilings. The job involves standing on a ladder or in a scissor lift, holding a 2-4 kg drill overhead with one hand, and pushing it upward with high force for 1-2 minutes while drilling a hole in the ceiling. Hundreds of these holes can be drilled during a day for hanging pipes, electrical trays and sheet metal ducts.

### Methods:

This 5 year project involved developing and testing six different drilling interventions which were designed to reduce the hand force and non-neutral shoulder postures associated with overhead drilling. Each design change was supported by participatory feedback from construction workers. This paper presents the evaluation of the final design.

During their regular overhead drilling, 23 commercial construction workers used the usual method and the intervention design - each for 3 hours – order randomized. Afterwards, subjects rated fatigue in 5 body regions and usability on 12 items. The work was videotaped for productivity (N=19) and inclinometers were used to measure shoulder posture and head inclination (N=16). Hand forces during drilling were measured for three subjects.

### Results:

The intervention device was rated superior to the usual method on the usability measures of drilling/vibration, stability, and feel/handling. Perceived fatigue ratings were significantly lower in all 5 body regions for the intervention device compared with the usual method. There was no significant difference in total time per hole between the usual method and the intervention device ( $p = 0.61$ ). The shoulder was flexed or abducted to over 60 degrees for 40% of the time while drilling with the usual method compared with 21% with the intervention ( $p = 0.007$ ). The percentage of time that the head was in extension of more than 0 degrees was greater for the usual method than the intervention ( $p = 0.005$ ). The mean applied hand force during drilling with the usual method was 245 (+/-11) N, and 26.3 (+/-3.3) N for the intervention.

### Conclusion:

An intervention device, compared to the usual method for overhead drilling, was associated with reduced upper extremity fatigue. This improvement was supported by reductions in the objective risk factors of applied force and percent time in non-neutral shoulder posture. Repeated field-testing by experienced construction workers and their feedback on design was vital to the development of this new intervention device.

**Keywords:** Postures, physical exposure, Construction, Intervention studies.

### References:

- National Institute for Occupational Safety and Health (NIOSH): Proceedings of a Meeting to Explore the Use of Ergonomics Interventions for the Mechanical and Electrical Trades (DDHS Pub. No. 2006-119), 2002. Cincinnati, Ohio: NIOSH.
- Rosecrance, J.C, T.M. Cook, and C.L. Zimmermann: Work related musculoskeletal disorders among construction workers in the pipe trades. *Work* 1996; 7:13–20.
- Rempel D, Star D, Barr A, Gibbons B, Janowitz I. A new method for overhead drilling. *Ergonomics* 2009; 52:1584-1589.



## IMPACT OF ERGONOMIC MEASURES ON PRODUCTIVITY, TASK DEMANDS AND WORKLOAD – EXAMPLES OF TWO CONSTRUCTION JOBS.

VAN DER MOLEN H.F., KUIJER P.P.F.M., FRINGS-DRESEN M.H.W.

Academic Medical Center, University of Amsterdam, Department: Coronel Institute of Occupational Health, Amsterdam, The Netherlands

### Aims:

To evaluate the impact of ergonomic measures on productivity, tasks demands and workload among pavers and among gypsum masons

### Methods:

A within-subjects controlled field study was performed to compare the effects of working with newly developed ergonomic measures to those of working with conventional working methods during the course of a full working day among pavers (n=8) and among gypsum masons (n=10). The outcome measures were productivity, duration and frequency of tasks and activities, energetic workload in terms of percentage heart rate reserve (%HRR), and cumulative spinal load (gypsum masons) or local discomfort and preferences (pavers).

For pavers a trolley was developed to reduce knee straining activities through increasing the rest periods while sitting. For gypsum masons adjustments in work organization and tools were made to reduce back straining activities through optimizing carrying distances and working height.

### Results:

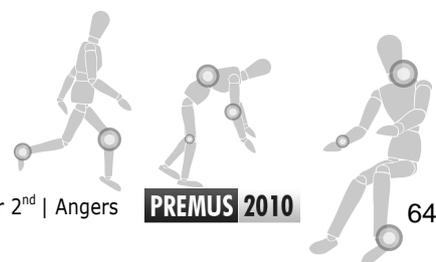
The use of a paver's trolley does not have an effect on productivity, nor on work demands and workload compared to working without a paver's trolley. Despite that, six of the eight pavers indicated that given suitable circumstances they want to use the paver's trolley.

The use of adjustments in work organization and tools among gypsum masons had no effect on productivity, total work time, duration of tasks, nor on duration of carrying, nor on the energetic or biomechanical workload during the course of a working day. Only during the finishing task, the duration and frequency of working below knee level decreased statistically significant by 4 minutes and 71 times, respectively.

### Conclusion:

No relevant preventive effects of the use of newly developed ergonomic measures on tasks demands and workload were found among pavers and among gypsum masons. The limited impact of the tested ergonomic measures argues for other measures to reduce the risk of work-related musculoskeletal complaints. These controlled feasibility studies underline the importance of assessing the effects of seemingly effective ergonomic measures at work sites before launching diffusion activities to implement such measures.

**Keywords:** Postures, physical exposure, Construction, Intervention studies.



## MASONRY ERGONOMICS BEST PRACTICES

WELCH L.S., ANTON D., HESS J.

CPWR - The Center for Construction Research and Training

### Aims:

The goals of this research are to reduce the incidence of work-related musculoskeletal disorders (MSDs) among masons by developing and implementing effective ergonomic controls. Work-related MSDs are common among masons due to the physical demands of their work; in 2005, the masonry industry in the US had the highest rate for back injuries and illnesses among all construction industries. Additional ergonomic controls and innovative means to disseminate those controls are needed in the masonry trade.

### Methods:

We conducted interviews and focus groups with contractors, workers, and architects, combined with field and laboratory evaluation of specific masonry practices and controls. In 2004 we convened a meeting of industry stakeholders and developed a list of available ergonomic controls. We conducted a telephone survey of 200 masonry contractors to assess advantages and barriers to use of these controls. We then evaluated several specific ergonomic controls, looking at ones for which no assessment was available.

### Results:

- 1) The national telephone survey of contractors found regional differences in use of innovations. Half-weight cement bags and AAC were rarely used anywhere while lightweight block and mortar silos appear to be diffusing in the southeast, midwest and west coast regions.
- 2) Lift Teams for handling 12" concrete block (CMU) improved spinal mechanics and have similar productivity to that of two masons working separately.
- 3) A comparison of laying CMU to autoclaved aerated concrete (AAC) found that CMU masons held block longer and performed more repetitive motions than AAC masons, with higher upper extremity stress. No significant differences were found in low back compressive force or workload.
- 4) Laying CMU block over vertical rebar exposes masons to upper extremity injury due to repetitive awkward postures and high forces associated with block weight. Alternatives to lifting block over rebar have been identified but are underutilized. We found that both H-block and the high lift grouting methods reduce arm elevation in flexion.

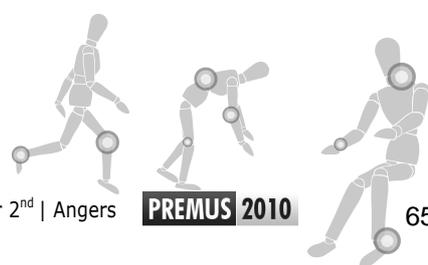
### Conclusion:

The telephone survey provided insight into innovation use and barriers to adoption that can be used by safety managers, researchers and other safety advocates to more effectively disseminate ergonomic solutions across the masonry industry. Evaluations of specific ergonomic controls, combined with other available assessments (e.g., lightweight CMU, adjustable scaffolding), provide a library of best practices for the industry. Future steps include packaging this information for dissemination to industry stakeholders and promoting the information through CPWR's Construction Solutions.

**Keywords:** Biomechanics, Construction, Back, low back.

### References:

- Hess JA, Kincl, LD, Amasay T, Peter Wolfe P [2010]. Ergonomic evaluation of masons laying concrete masonry units and aerated autoclaved concrete. (submitted for publication)
- Hess JA, Weinstein M, Welch L [2010]. Ergonomic solutions in masonry: Regional differences, benefits and barriers. (submitted for publication).
- Meyers A, Anton D, Hess J, Fethke N, Gerr F [2010]. Effect of concrete block weight and wall height on back posture, lumbar kinematics, low back disorder risk probability, and electromyographic back muscle activity among masons. (submitted for publication).



## ECONOMIC EVALUATION OF INTERVENTIONS TO REDUCE ERGONOMIC INJURIES IN CONSTRUCTION

LAHIRI S., WELCH L.S.

University of Massachusetts Lowell; CPWR - The Center for Construction Research and Training, USA

### Aims:

To develop and validate a web-based calculator from the employer's perspective for estimating the return on investment (ROI) from ergonomic interventions in construction

### Methods:

We have adapted the net-costs model developed by Lahiri (2005) for use in the construction industry. The model measures all costs paid by an employer to implement interventions to reduce MSDs and all costs avoided plus any improvements in productivity. It has been refined to ensure that the employer can use it as an ex-ante (before-the-fact) tool as opposed to ex-post (after-the-fact). A distinction is made between self-insured contractors and the contractors that purchase insurance from third party providers. The adapted version includes a calculation of savings from workers compensation insurance through the experience rating formula that follows from a reduction in compensable injuries; this addition allows the model to be used by both non-self insured and self-insured contractors. We have developed case studies to illustrate assumptions about injury reduction and changes in productivity; these data will allow a contractor to calculate ROI for solutions that have not been evaluated in a prospective fashion. The calculator will also permit sensitivity analysis, looking at ROI under different assumptions about injury reduction and changes in productivity. We have tested the prototype with construction contractors, and made progressive changes over three successive rounds of usability testing.

### Results:

We will present results of two case studies: lightweight block and mast-climbing scaffolding to illustrate the use of the calculator, describing the usability of the testing process and its results.

### Conclusion:

The World Health Organization (2002) published a review about the cost-effectiveness of using interventions to reduce exposure to various occupational risk factors, and in 2004 NIOSH and the WHO hosted a meeting to review available tools for determining ROI for occupational health interventions (Biddle 2005). A goal to disseminate ROI and cost information is listed among NIOSH strategic goals for injury reduction (NAS 2008 traumatic injury research book) and for the construction industry. When the National Academies of Science reviewed NIOSH's construction program for relevance and impact (NAS 2008) the committee specifically noted that additional research is needed on the economics of preventing ergonomic injury. Although we believe that providing cost information and ROI would motivate contractors to adopt solutions for safety and ergonomic hazards, we do not yet have evidence that this actually occurs.

**Keywords:** Construction, Intervention studies, Economics.

### References:

Lahiri, S., Gold, J., and Levenstein, C. Estimation of Net-Costs for Prevention of Occupational Low Back Pain: Three Case Studies From the US. *American Journal of Industrial Medicine* 2005;48: 530-541  
Biddle, E., Ray T., Owusu-Edusei, K. and Camm Jr. T. Synthesis and recommendations of the economic evaluation of OHS interventions at the company level conference. *Journal of Safety Research* 2005;36: 261-267.



## INTERNATIONAL PERSPECTIVES ON HEALTH-RELATED WORK OUTCOME MEASURES

### **Symposium Description**

There is a recognized need for economic evaluations of interventions to prevent MSDs. Recently, researchers have recognized the importance of lost productivity at work as one component of the economic evaluation. This has led to a growth of different measurement tools, often termed 'presenteeism' or work ability measures, without clear consensus on which tools are most appropriate in MSD research and for the prevention and management of work disability.

In this symposium, we will present results from studies conducted in The Netherlands, the United States, Canada and Brazil. We will identify the strengths and limitations of the tools and discuss their application in MSD research. The goal of the symposium is to provide the conference attendees with better knowledge about the tools and their use in research.

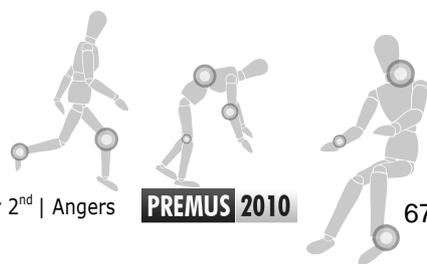
### **Symposium Author**

Benjamin C. AMICK, Institute for Work & Health, Toronto, Canada; University of Texas School of Public Health, Health Science Center at Houston, Houston, Texas, USA

Ute BÜLTMANN, Department of Health Sciences, Work & Health, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands

### **Authors linked to the Name of their abstract symposium**

ABMA F.	The cross cultural adaptation of the work role functioning questionnaire to Dutch
AMICK B.	The use of work role functioning in evaluating an ergonomic intervention
BULTMANN U.	Work limitations among workers in a manufacturing company in Denmark
GALLASCH C.	Measuring work limitations in Brazilian health care workers



## **THE CROSS CULTURAL ADAPTATION OF THE WORK ROLE FUNCTIONING QUESTIONNAIRE TO DUTCH**

ABMA F.I., AMICK B.C., BROUWER S., VAN DER KLINK J.J.L., BÜLTMANN U.

*University Medical Center Groningen, University of Groningen, The Netherlands*

### **Aims:**

Work disability is a prevalent problem in industrialized countries. Moreover, due to the ageing workforce and advances in medical treatments, more persons will likely participate in the labor force with a health problem that might interfere with their ability to perform their job demands. Traditional outcome measures of work status, disability duration and compensation costs do not provide information on how well a person can perform her/his job. In the Netherlands, no native or cross-culturally adapted health-related work outcome measure is available and validated to assess the impact of a health problem on work functioning. The objectives of this study are 1) to conduct a cross-cultural adaptation of the Work Role Functioning Questionnaire (WRFQ), an instrument measuring the perceived impact of a health problem on the workers' ability to perform the job, to Dutch and 2) to assess the questionnaire's reliability and validity in the Dutch context.

### **Methods:**

The WRFQ translation and adaptation were conducted using a systematic approach with the following steps: forward translation, synthesis, back-translation, consolidation of translations with expert committee, and pre-testing. In the pre-test, the usability, the applicability, the comprehensibility and the completeness of the questionnaire were evaluated. Therefore, a total of 40 workers with a health problem, who are at work, were invited for participation. These workers were identified by their occupational physician and invited to participate in the pretest. Directly after completing the questionnaire, they answered several questions about the wording of the instructions and items, the lay-out, and whether they missed aspects of their functioning.

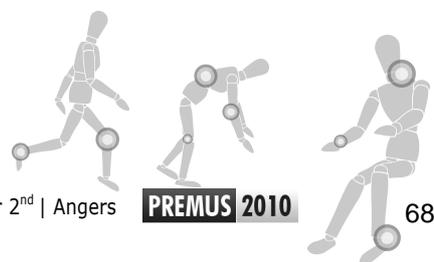
### **Results:**

The questionnaire translation was conducted without any major difficulties. During the process, questionnaire instructions were modified and 5 items reformulated based on the participants' responses. The participants were positive on the comprehensibility, usability, applicability and completeness of the questionnaire, and also made suggestions for the further development of the WRFQ-Dutch version. Furthermore, the study showed Cronbach's alpha's for the WRFQ-DV subscales between 0.70 and 0.91 and a good content validity.

### **Conclusion:**

The results indicate that the cross-cultural adaptation of the WRFQ-DV was successful and that the psychometric properties of the translated version are promising for the Dutch context.

**Keywords:** Epidemiology, Early prevention, Disability prevention.



## THE USE OF WORK ROLE FUNCTIONING IN EVALUATING AN ERGONOMIC INTERVENTION

AMICK B.C., BAZZANI L., ROBERTSON M., DE RANGO K.

*Institute for Work & Health, Toronto, Canada*

### **Aims:**

While work role functioning and other 'presenteeism' measures have been widely used in observational studies and in clinical evaluation studies, few studies report the use of 'presenteeism' measures in ergonomic interventions. We report the use of work role functioning in a non-randomized field trial of a new ergonomic chair and training. The primary hypothesis is does the ergonomic intervention significantly improve work role functioning?

### **Methods:**

Data come from 2 intervention studies in a public sector and private sector organization. Data collection occurred two months and one month prior to the intervention and two, six and twelve months post-intervention. During each round, a work environment and health questionnaire was completed via the Internet. The intervention was a highly adjustable ergonomic chair and an office ergonomics training (Amick 2004). One group received only the training and a control group received the training at the end of the study. Work role functioning (WRF) was measured following Amick (2000). It is a 27-item questionnaire with a Cronbach alpha of .92. WRF varies from 0-100 with 100 functioning well in the job and 0 unable to functioning in job for a given state of physical and emotional health. All analyses were conducted using multi-level modelling with work role functioning nested within individuals within intervention site.

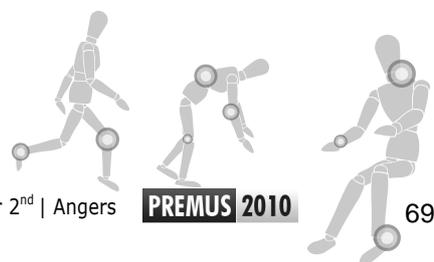
### **Results:**

The overall sample included 414 individuals. Intervention site was non-significant and thus results are reported for both sites combined. Overall, the chair-with-training intervention was marginally non-significant in improving work role functioning ( $p=0.06$ ). However, three of five subscales (physical demands, mental demands, social demands) were significantly improved while two were not (scheduling and output demands).

### **Conclusion:**

Workers who received a highly adjustable chair and office ergonomics training had improved work role functioning in meeting the physical, mental and social demands of the job. In a knowledge workforce with significant interactions with customers these demands are critical to being an effective performer. These results show the importance of using a multidimensional scale compared to a shorter scale. Future work should continue to test the usability of this type of measure in ergonomic interventions.

**Keywords:** Intervention methods, Disability prevention, Economics.



## WORK LIMITATIONS AMONG WORKERS IN A MANUFACTURING COMPANY IN DENMARK

BÜLTMANN U.<sup>1</sup>, AMICK B.C.<sup>2</sup>, SELL L.<sup>3</sup>, HOLTERMANN A.<sup>3</sup>, SØGAARD K.<sup>4</sup>

<sup>1</sup> Department of Health Sciences, University Medical Center Groningen, Groningen, The Netherlands – <sup>2</sup> Institute for Work & Health, Toronto, Canada – <sup>3</sup> National Research Centre for the Working Environment, Copenhagen, Denmark – <sup>4</sup> Institute of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark

### Aims:

The prevention and management of work disability due to musculoskeletal disorders are high on the social and political agenda in Denmark. Moreover, the increasing awareness of the promotion of a sustainable working life has led to the recognition that there is a need for measurement tools that can describe how workers can accomplish their work roles. The aim of this study was to examine the psychometric properties of the Danish version of the 15-item Work Role Functioning Questionnaire (WRFQ) among workers of a manufacturing company in Denmark.

### Methods:

A sample of 453 workers from a Danish manufacturing company participated in the study. To assess the limitations at work, as experienced by the workers, during the past 4 weeks, the 15-item WRFQ was used, covering work scheduling demands, output demands, physical demands, and social/psychological demands. We evaluated the item performance and scale reliability of the WRFQ and related the scores to other self-reported measures, such as general health, the presence of a musculoskeletal disorder, and work ability.

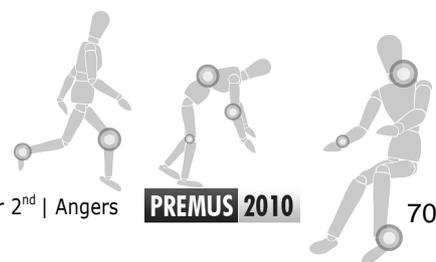
### Results:

The majority of the participants (n=375 manufacturing work, n=78 administrative work) reported a good/very good health (85%). Musculoskeletal disorders were reported by 10%, while 20% reported reduced work ability due to injury/illness to some or a large extent. WRFQ scores were skewed towards no difficulties in accomplishing the work role, with ceiling effects present in all subscales. Some difficulties in meeting the work demands were reported across all subscales, but mainly for output demands. The Cronbach's alpha's for the subscales were between 0.77 (physical demands) and 0.93 (output demands). Items with the highest scores of "Does not apply to my job" were "Keeping body in one position", "Using hand-operated tools", and "Lifting objects" of the physical demands subscale. The range of the item-to-subscale correlations per subscale were above 0.66, except for one item in the physical demands scales (0.36). Workers with a less favorable health condition or reduced work ability consistently reported more difficulties in meeting the work demands.

### Conclusion:

This study showed that the translated Danish version of the 15-item WRFQ provided valuable information on the ability to accomplish the work role among workers in a manufacturing company. Further research is needed on the test-retest reliability, validity, and responsiveness of the instrument, thereby paying specific attention to the physical demands subscale.

**Keywords:** Epidemiology, Early prevention, Disability prevention.



**MEASURING WORK LIMITATIONS IN BRAZILIAN HEALTH CARE WORKERS**

GALLASCH C.H., ALEXANDRE N.M.C.

*Department of Nursing, Faculty of Medical Sciences, State University of Campinas (UNICAMP), Brazil***Aims:**

In Brazil, Work-related Musculoskeletal Disorders (WRMD) have been rising over the last few decades, reaching up to 21% of workers in some Brazilian regions. In 2007, 653.090 occupational accidents and diseases were registered, representing 580.592 cases of temporally and 8504 permanent disabilities. Health care workers are commonly affected by dorsal symptoms, and low back pain is a common problem, because of handling and moving patients. Questionnaires have been considered useful to identify symptoms and to investigate correlated factors. Two studies are presented, with the objectives to investigate ergonomic risks in different hospital units from a State Hospital; and to translate and adapt the Work Role Functioning Questionnaire (WRFQ) into the Brazilian Portuguese language, evaluating its reliability in patients suffering from WRMD.

**Methods:**

Data collection tool applied was the Risk Assessment Scale for Moving and Transference which is based on the ergonomic theory and has reliable psychometric properties. Cross-cultural adaptation of the WFRQ was performed according to the internationally recommended methodology. Psychometric properties were obtained by reliability – stability and homogeneity assessment – and construct validity.

**Results:**

Results showed that the ICU had the largest percentage of patients presenting ergonomically high risk for health care workers. Patients from the surgical units offered average risk, while most of the clinical medicine unit patients were ergonomically of low risk. About WRFQ Brazilian version, results indicated good content validity and internal consistency. Test-retest reliability was satisfactory for mental demands and excellent for the others (Table 1).

**Table 1** Cronbach's alpha coefficient for each WRFQ sub-scale (Brazilian Portuguese version)

	Number of items	Cronbach's alpha
Work scheduling demands	5	0.88
Physical demands	6	0.86
Mental demands	6	0.93
Social demands	3	0.57
Output demands	7	0.89

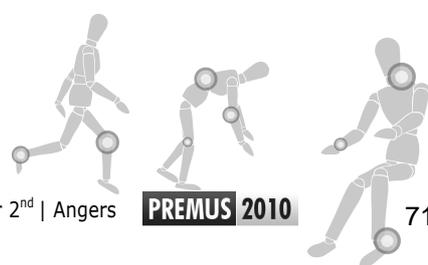
**Conclusion:**

Cross-cultural adaptation process was successful and the adapted instrument has good psychometric properties to use in the Brazilian culture. According to these results, is possible to combine evaluations of the work places and the worker to acquire material and equipment according to special needs and to promote preventive programs and rehabilitation in the work place.

**Keywords:** Health care workers, Disability prevention, Back, low back.

**References:**

- Gallasch CH, Alexandre NMC, Amick BC. Cross-cultural Adaptation, Reliability and Validity fo the Work Role Functioning Questionnaire to Brazilian Portuguese. *J Occup Rehabil.* 2007; 17: 701-11.
- Durand MJ, Vachon B, Hong QN, Imbeau D, Amick BC, Loisel P. The cross- cultural adaptation of the Work Role Functioning Questionnaire in Canadian french. *Int J Rehabil* 2004; 27(4):261–8.
- Gallasch CH, Alexandre NMC. Avaliação dos riscos ergonômicos durante a movimentação e transporte de pacientes em diferentes unidades hospitalares. *R Enferm UERJ.* 2003; 11: 252-60.



## INTERVENTIONS FOR REDUCING WORK ABSENCE FOR WORKERS WITH MUSCULOSKELETAL DISORDERS - INNOVATIONS AND NEW DEVELOPMENTS

### **Symposium Description**

In the past decade, there has been a consolidation of knowledge around the principles of effective early return-to-work strategies and interventions for workers with musculoskeletal disorders. This symposium we will focus on emerging developments and innovations in this area. The prognostic use of an early screening measure will be presented, as well as its implications for intervention. New qualitative data regarding the experiences of workers with prolonged work absence participating in vocational rehabilitation will be presented. In addition, workplace and worker-based predictors of work accommodation offers and acceptance will be examined, and their implications for policy will be considered.

Return-to-work interventions continue to integrate a wider set of elements and of partners. As such, their effectiveness need to be considered in a new light. In this symposium, two recent systematic reviews of workplace-based return-to-work interventions will be presented, one focusing on work absence duration and health outcomes, the other on economic outcomes. The effectiveness of an integrated care program for workers with chronic back pain will then be presented, followed by a discussion of the challenges and models of interorganisational collaboration in the context of return-to-work interventions.

### **Symposium Author**

Dr. Renee-Louise FRANCHE

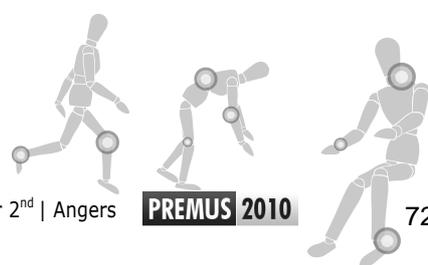
### **Authors linked to the Name of their abstract symposium**

#### **Part I**

SHAW W.S.	Development of the inventory of pain, recovery expectations, and concerns (IPREC): a patient-centered screening tool to match working adults to early intervention fo low back pain
MACEACHEN E.	Re-integrating injured workers to the labour market and the problem of poor health
FRANCHE R.L.	A multivariate analysis of factors associated with early offer and acceptance of a work accomodation following an occupational musculoskeletal injury
MUIJZER A.	Assessment of the quality of the return-to-work process among sick-listed workers with low back pain: a focus group study
TREMBLAY-BOUDREAULT V.	Combining disability prevention to return to work management: an innovative step towards better MSD management

#### **Part II**

ANEMA H.	Cochrane review about workplace interventions for preventing work disability
TOMPA E.	A systematic review of disability management interventions with economic evaluations
KILSGAARD J.	Coordinated and tailored work rehabilitation: challenges of implementing a cost effective program in an interorganisational setting



## DEVELOPMENT OF THE INVENTORY OF PAIN, RECOVERY EXPECTATIONS, AND CONCERNS (IPREC): A PATIENT-CENTERED SCREENING TOOL TO MATCH WORKING ADULTS TO EARLY INTERVENTION FOR LOW BACK PAIN

SHAW W.S.<sup>1,2</sup>, LINTON S.J.<sup>3</sup>, STEENSTRA I.<sup>4</sup>, PRANSKY G.<sup>1,2</sup>

<sup>1</sup> Liberty Mutual Research Institute for Safety, Hopkinton, MASSACHUSETTS, USA - <sup>2</sup> University of Massachusetts Medical School, Worcester, MASSACHUSETTS, USA - <sup>3</sup> Orebro University, Orebro, Sweden - <sup>4</sup> Institute for Work & Health, Toronto, Canada

### Aims:

Approximately one-third of patients with acute low back pain (LBP) experience lingering symptoms and functional limitation that can lead to chronic pain and disability. While most treatment guidelines suggest only conservative care for acute LBP, recent evidence suggests that “yellow flags” for back disability may be present as early as the first day of pain; thus, early intervention may be effective if matched to the needs of high-risk patients.

### Methods:

A review of the literature was conducted to: (1) identify candidate measures within the 3 prognostic domains of pain beliefs, functional perceptions, and workplace characteristics. Based on the strength of psychometric evidence and consistent associations with LBP outcomes, 6 existing measures were chosen: (1) CES-D depression scale; (2) Pain Catastrophizing Scale; (3) Tampa Kinesiophobia Scale; (4) Quebec Back Pain Disability Scale; (5) Physical Workload Survey; and (6) Perceived Organizational Support scale. Three new measures were the Life Impact of Pain Scale (9 items); the Return-to-Work Self-Efficacy scale (28 items); and the Expected Time to Recovery scale (3 items). This battery of 9 self-report scales was administered to 293 adults (61% male, median age 35) participating in an inception cohort study of work-related LBP. Pain, dysfunction, and return to work were assessed at 3 months.

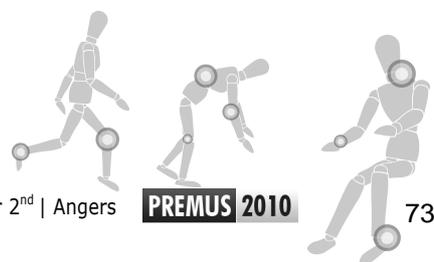
### Results:

All scales met criteria for reliability and validity. For participants with complete survey data (n=273), standardized scale scores were subjected to a K-means cluster analysis to determine whether patient groups could be identified. A 4-cluster solution met criteria for interpretability while maintaining sufficient distance between cluster centers (Mahalanobis' distance): (1) a low risk group (39%) requiring no intervention; (2) a high risk group (14%) requiring multidisciplinary intervention; (3) a “workplace concerns” group (31%) requiring early workplace contact; and (4) a “worried well” group (18%) with distorted views about pain and recovery that might benefit from brief education and support. Full-duty return to work at 3 months was 91% for the low-risk group, 83% for the “worried well” group, 82% for the “workplace concerns” group, and 47% for the high-risk group (p<.05).

### Conclusion:

This study provides evidence of risk factor profiles that might provide a useful decision-making tool for early intervention, but future studies are needed to assess the cost-effectiveness of employing such treatment decision trees.

**Keywords:** Psychosocial factors, Disability prevention, Back, low back.



## **RE-INTEGRATING INJURED WORKERS TO THE LABOUR MARKET AND THE PROBLEM OF POOR HEALTH**

MACEACHEN E., KOSNY A., FERRIER S., NELSON C., LIPPEL K., FRANCHE R.L.

Institute for Work & Health, Toronto, Canada

### **Aims:**

In some instances, the severity of a work injury precludes the ability to return to a place of employment. In many jurisdictions, state programs exist to provide such workers with new skills so that they can find alternative work that is within their remaining functional abilities. This aspect of the return-to-work continuum is rarely addressed in scientific research, which tends to focus on workers who recover and return to their pre-injury jobs. This explorative qualitative study examined how a return-to-labour market training program was experienced and carried out in Ontario, Canada.

### **Methods:**

Using a sociological approach that examines patterns of practice and behaviour, we examined direct injured worker and provider experience of Ontario's Labour-Market Re-entry (LMR) program. This program is provided by the workers' compensation authority who subcontracts it to external providers. The data consist of interviews and focus groups across regions of Ontario with 71 injured workers, employers, labour market re-entry service providers, educators, workers' compensation staff, and worker representatives. Publicly available documents, such as service provider advertising materials, were also included in the analysis. Following general analytic approaches of grounded theory and discourse analysis, we examined the situated narrative of participants and identified contradictory and recurrent themes.

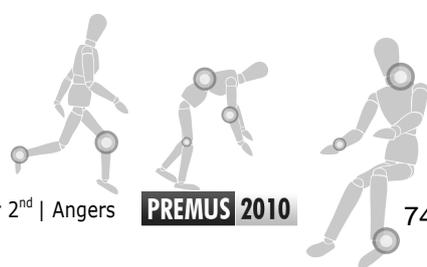
### **Results:**

Workers and providers in the LMR program struggled with the problem of ill-health. Worker pain, strong medication use, depression, and surgeries were described as key barriers to retraining and job success. However, the LMR program assumes good worker well being and was not designed to consider ongoing health problems. Communication about the problem of worker ill-health was thwarted by dynamics of outsourcing arrangements with contractors who provided LMR program services. Official rules about 'maximum medical rehabilitation' and about what kinds of work injury problems are covered by workers' compensation insurance meant that providers could not adequately manage worker health problems that posed a serious barrier to program success.

### **Conclusion:**

We discuss the logic of the labour market re-entry program and the lack of fit of this logic with the practical realities of workers' poor health situations. We draw attention to a relatively overlooked subgroup of injured workers who cannot return to their previous employment, and to complications related to the limited design of a service program. Suggestions for injured worker retraining interventions are put forth.

**Keywords:** Return to work, Public policy, Pain, chronic pain.



## A MULTIVARIATE ANALYSIS OF FACTORS ASSOCIATED WITH EARLY OFFER AND ACCEPTANCE OF A WORK ACCOMMODATION FOLLOWING AN OCCUPATIONAL MUSCULOSKELETAL INJURY

FRANCHE R.L., SEVERIN C., HOGG-JOHNSON S., LEE H., CÔTÉ P., KRAUSE N.

*Occupational Health and Safety Agency for Healthcare, Vancouver, Canada*

### Aims:

Work accommodation is a critical element of effective return-to-work (RTW) interventions (1,2). However, little is known about what factors facilitate the work accommodation process. Our study's main objective was to identify workplace and individual factors associated with offer and acceptance of work accommodation.

### Methods:

The sample consisted of 401 workers with work-related musculoskeletal injuries from Ontario, Canada, who had filed a claim to the Workplace Safety and Insurance Board (WSIB) of Ontario. Data was obtained from participant interviews one month post-injury, and from WSIB administrative data. Two logistic regressions identified factors associated with work accommodation offer and acceptance.

### Results:

One month post-injury, 58% of workers had received a work accommodation offer. Of those, 76% had accepted the offer. The main reason for refusing work accommodation was not being physically able to go back to work (92.4%), and, 65% reported that by refusing the work accommodation, they were following their doctor's recommendations. Logistic regressions indicated that unionized status, strong disability management policies and practices, low supervisor support, and pink collar occupation were associated with work accommodation offer. Job tenure of one year or more, and lighter physical work were associated with acceptance. Younger age and more repetitive physical work demands were positively associated with both outcomes. Pink collar status was positively associated with offers, but negatively with acceptance. Gender, mental health, pain, job satisfaction, firm size, people-oriented culture, safety climate, ergonomic practices were not significant predictors.

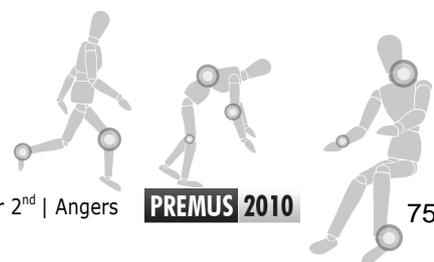
### Conclusion:

Early in the RTW trajectory, workplace factors are better predictors of offer and acceptance of work accommodation, than individual factors. Unionization and strong organizational disability management policies and practices are salient for work accommodation offers, whereas longer job tenure is salient for acceptance of offers. A surprising finding concerned supervisor support – it is possible that within the short follow-up period of our study, a supportive supervisor did not “pressure” a worker to come back to work by not offering a work accommodation and allowing for recovery time. However, within a longer follow-up, a previous study found that a supportive supervisor would facilitate return to work by offering a work accommodation (3). Overall, our findings suggest that for policy-makers, more attention needs to be placed early on in the RTW process on job-level factors, workplace-level factors, and policy about mandatory work accommodation, to improve work disability outcomes.

**Keywords:** Psychosocial factors, Work organization, Return to work.

### References:

1. Franche R-L, Severin CN, Hogg-Johnson S, Côté P, Vidmar M, Lee H. The impact of early workplace-based return-to-work strategies on work absence duration: A 6-month longitudinal study following an occupational musculoskeletal injury. *J Occup Environ Med.* 2007;49:960-974.
2. Krause N, Dasinger LK, Neuhauser F. Modified work and return to work: a review of the literature. *J Occup Rehab.* 1998;8:113-139.
3. Nielsen ML, Rugulies R, Christensen KB, Smith-Hansen L, Kristensen TS. Psychosocial work environment predictors of short and long spells of registered sickness absence during a 2-year follow up. *J Occup Environ Med.* 2006;48:591-598.



## **ASSESSMENT OF THE QUALITY OF THE RETURN-TO-WORK PROCESS AMONG SICK-LISTED WORKERS WITH LOW BACK PAIN: A FOCUS GROUP STUDY**

MUIJZER A., GEERTZEN J.H.B., DE BOER W.E.L., GROOTHOFF J.W., BROUWER S.

*Department of Health Sciences, University Medical Center Groningen, University of Groningen, the Netherlands*

### **Aims:**

Low back pain (LBP) is an important cause of work disability and sickness absence. An effective return-to-work (RTW) process is necessary to prevent LBP from becoming a chronic condition, and thereby leading to applications for disability benefits. In order to promote RTW, sufficiency of RTW efforts, i.e. all efforts (vocational and non-vocational) designed to increase the chance of RTW, is very important. However, the quality and effect of the RTW process is influenced by a large number of factors, which makes the operationalization of 'sufficient RTW efforts' and the assessment of the RTW process a unique challenge.

The main aim of this study was to identify which factors determine sufficiency of RTW efforts, by investigating arguments and underlying grounds relevant to the assessment of RTW efforts of sick-listed employees with low back pain.

### **Methods:**

Two cases were selected which represent employees on sickness absence for two years due to low back pain. Each case was presented to Labour Experts (LE's) working at the Social Insurance Institute (SII) in the Netherlands. Data was gathered by means of a stepwise semi-structured approach in which professionals first received one of the cases. Using the case, each LE provided arguments for the decision on sufficiency of RTW efforts individually.

The LE's were then joined in a focus group meeting, during which underlying grounds for arguments were discussed. After this, factors were identified from the grounds by the researchers, and were grouped in themes to match the International Classification of Functioning, Disability and Health (ICF)-model, to improve comparability and to provide a clear overview.

### **Results:**

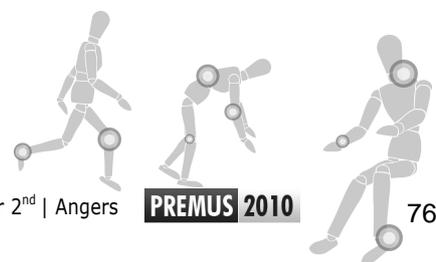
A total of fifteen professionals provided arguments relevant to the sufficiency of RTW efforts. After analysis of the arguments provided for the assessment of RTW efforts, three main themes emerged. The first theme includes factors such as level of (dis)ability and competencies (personal level), the second theme includes number of jobs available (external level), and one theme focuses on factors such as workplace interventions and guidance by employer (RTW interventions).

### **Conclusion:**

The determinants of sufficiency of RTW efforts encompass the full width of the ICF-model. Determination of sufficiency of RTW efforts is essential to assess and improve the quality of the RTW process.

Further analyses of the relation between themes and the assessment of RTW efforts will be performed early 2010.

**Keywords:** Disability prevention, Return to work, Back, low back.



## COMBINING DISABILITY PREVENTION TO RETURN TO WORK MANAGEMENT: AN INNOVATIVE STEP TOWARDS BETTER MSD MANAGEMENT

TREMBLAY-BOUDREAU V., VÉZINA N.

University of Québec in Montréal (UQAM), Montréal, Canada

### Aims:

A study was realized in Quebec (Canada) to develop a training program designed to improve prevention of MSD and related return to work management in a specific rubber plant. We also identified facilitators and barriers to its implementation.

### Methods:

This case study was realized, over a period of ten months, in a plant characterized by high level of constraints, limited financial resources and aging employees at high risk of MSD. Based on a participatory ergonomics approach (Guérin & al., 2006), the training program was developed by an ergonomist student within the course of a master's degree. Semi-structured interviews with the eleven main health and safety actors (production directors (n=2), human resources counselor, supervisors (n=4) and prevention representatives (union, n=4)), followed by the active observation of the prevention activities already in place, allowed the ergonomist to identify the training needs of the actors. Content of the training program was inspired from different tools available in the literature (Occupational Health and Safety Council of Ontario, 2007; Stock & al., 2005) taking into consideration the characteristics of the plant and the actors' training needs. Two two-hour meetings with the main health and safety actors were held to develop a new return to work management procedure. The ergonomist conducted semi-structured interviews (n=11) to identify the facilitators and barriers to implementation of the training program.

### Results:

The proposed program represents an innovative combination of topics on disability prevention and return to work management addressed by group sessions, individual bi-monthly support, and through a participatory analysis of a work station. The program also included integration of workers through global management of MSD. The ultimate outcome for the actors was a better understanding of MSD and of their own impact, allowing them to better use the task analysis to propose modified work within the new return to work management procedure. Thus, a more structured and coherent management of MSD by the enterprise could be provided. Facilitators and barriers mainly focused on organizational context, knowledge and ability level of the actors and proposed tools.

### Conclusion:

The main contribution of our intervention was to combine disability prevention to return to work management to propose a continuum of MSD management adapted to the needs of a rubber plant. The latter combination seems to be essential in order to capitalize on proper MSD management.

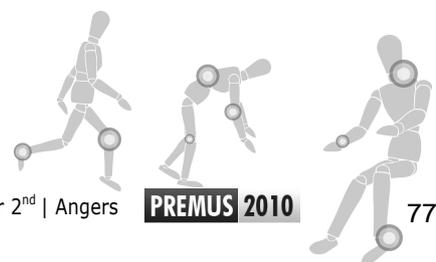
**Keywords:** Intervention studies, Disability prevention, Return to work.

### Reference:

Guérin F, Laville A, Daniellou F, Duraffourg J, Kerguelen, A. Comprendre le travail pour le transformer : La pratique de l'ergonomie. Lyon : Éditions du réseau ANACT; 2006.

Occupational Health and Safety Council of Ontario (OHSCO). Musculoskeletal Disorders Prevention Series. Part 2: Resource Manual for the MSD Prevention. Retrieved November 18, 2007, from [http://www.wsib.on.ca/wsib/wsibsite.nsf/Public/fr\\_preventmsd](http://www.wsib.on.ca/wsib/wsibsite.nsf/Public/fr_preventmsd)

Stock S, Baril R, Dion-Hubert C, Lapointe C, Paquette S, Sauvage J, Simoneau S, Vaillancourt C et al. [Work-related Musculoskeletal Disorders - Guide and Tools for Modified Work]. Troubles musculosquelettiques : Guide et outils pour le maintien et le retour au travail. Montréal : Institut de recherche Robert-Sauvé en santé et sécurité du travail, Direction de la santé publique, Agence de développement de réseaux locaux de services de santé et de services sociaux de Montréal; 2005.



## COCHRANE REVIEW ABOUT WORKPLACE INTERVENTIONS FOR PREVENTING WORK DISABILITY

VAN OOSTROM S.H., DRIESSEN M.T., DE VET H.C.W., FRANCHE R.L., SCHONSTEIN E., LOISEL P., VAN MECHELEN W., ANEMA J.R.

EMGO Institute of Health and Care Research, Amsterdam, The Netherlands

### Aims:

To determine the effectiveness of workplace interventions compared to usual care or clinical interventions on work-related outcomes and health outcomes; and to evaluate whether the effects differ when applied to musculoskeletal disorders, mental health problems, or other health conditions.

### Methods:

We searched the Cochrane Occupational Health Field Trials Register, CENTRAL, MEDLINE and EMBASE (EMBASE.com), and PsycINFO databases (to November 2007). Randomized controlled trials of workplace interventions aimed at return to work were included. Two authors independently extracted data and assessed risk of bias of the studies. Meta-analysis and qualitative analysis (using GRADE levels of evidence) were performed.

### Results:

Six randomized controlled trials were included (749 workers): three on low back pain, one on upper-extremity disorders, one on musculoskeletal disorders, and one on adjustment disorders. Five studies were rated as having low risk of bias for the sickness absence outcome. The results of this review show that there is moderate-quality evidence to support the use of workplace interventions to reduce sickness absence among workers with musculoskeletal disorders when compared to usual care. However, workplace interventions were not effective to improve health outcomes among workers with musculoskeletal disorders. The lack of studies made it impossible to investigate the effectiveness of workplace interventions among workers with mental health problems and other health conditions.

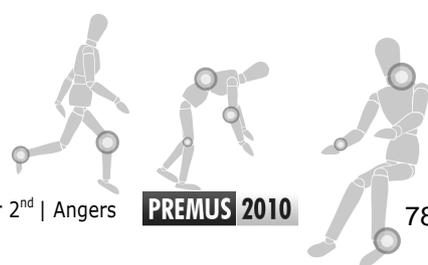
### Conclusion:

As a result of the few available studies, no convincing conclusions can be formulated about the effectiveness of workplace interventions on work-related outcomes and health outcomes regardless of the type of work disability. The pooled data for the musculoskeletal disorders subgroup indicated that workplace interventions are effective in the reduction of sickness absence, but they are not effective in improving health outcomes. The evidence from the subgroup analysis on musculoskeletal disorders was rated as moderate-quality evidence. Unfortunately, conclusions cannot be drawn on the effectiveness of these interventions for mental health problems and other health conditions due to a lack of studies.

**Keywords:** Intervention studies, Return to work.

### References:

Van Oostrom SH, Driessen MT, de Vet HCW, Franche RL, Schonstein E, Loisel P, et al. Workplace interventions for preventing work disability [Cochrane Review]. Cochrane Library 2009;15(2 Art. No.: CD006955. DOI: 10.1002/14651858.CD006955.pub2).



## A SYSTEMATIC REVIEW OF DISABILITY MANAGEMENT INTERVENTIONS WITH ECONOMIC EVALUATIONS

TOMPA E., DE OLIVEIRA C., DOLINSCHI R., IRVIN E.L.

*Institute for Work & Health, Toronto, Canada*

### **Aims:**

We undertook a systematic literature review of disability management interventions to answer the question: “what is the credible evidence that incremental investment in disability management interventions is worth undertaking?” Previous reviews have confirmed the effectiveness of disability management interventions [1] and analysed their dimensions, processes and practices [2], while our review complements these with confirmation of their economic merits.

### **Methods:**

We identified studies through searches in journal databases and requests to content experts. After assessing the quality of studies that met content requirements, we employed a best-evidence synthesis approach. Studies were stratified across several dimensions for evidence synthesis, with industry as the core stratification criterion.

### **Results:**

We identified 17 disability management interventions with economic analyses, of which 8 were of high or medium quality. We found strong evidence supporting the economic merits of multi-sector disability management interventions, but could not make a positive statement about the remaining five industry clusters with studies. For stratification by intervention components, we found moderate evidence for interventions that included an education component, moderate evidence for those with physiotherapy, limited evidence for those with a behavioural component, and moderate evidence for those with a work/vocational rehabilitation component. For stratification by intervention features, we found moderate evidence for interventions that included a work accommodation offer, contact between health care provider and workplace, early contact with worker by workplace, ergonomic work site visits, and for interventions with a return-to-work coordinator.

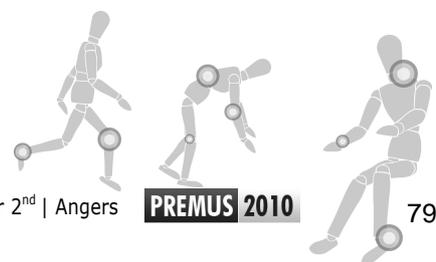
### **Conclusion:**

We found credible evidence supporting the financial benefits of disability management interventions for one industry cluster and several intervention components and features. Our findings are of value to workplace parties, OHS practitioners, and policy-makers who are interested in knowing not only if disability management interventions are effective, but also if they are worth undertaking based on their financial benefits. Our review also highlights the need for more systematic consideration of the economic merits of disability management intervention studies, and further development of standardized analytic methods in order to ensure a larger and more reliable evidence base in this domain.

**Keywords:** Intervention studies, Disability prevention, Economics

### **References:**

Franché R-L, Cullen K, Clarke J, Irvin E, Sinclair SJ, Frank JW. Workplace-based return-to-work interventions: A systematic review of the quantitative literature. *Journal of Occupational Rehabilitation* 2005;15(4):607-31. MacEachen E, Clarke J, Franché R-L, Irvin E, Workplace-based Return to Work Literature Review Group. Systematic review of the qualitative literature on return to work after injury. *Scandinavian Journal of Work, Environment and Health* 2006;32(4):257-69.



## COORDINATED AND TAILORED WORK REHABILITATION: CHALLENGES OF IMPLEMENTING A COST EFFECTIVE PROGRAM IN AN INTERORGANISATIONAL SETTING

KILSGAARD J., SHERSON D., OLSEN J., HANSEN C.L., LUND T., BÜLTMANN U.

KIApro, Gladsaxevej 342, DK-2860 Soborg, Denmark.

### Aims:

In Denmark, the magnitude and impact of work disability on the individual worker and society has prompted the development of a new “coordinated and tailored work rehabilitation” (CTWR) approach. The aims of this study were 1) to compare the effects of CTWR with conventional case management (CCM) on return to work of workers on sick leave due to musculoskeletal disorders (MSDs) and 2) to describe the challenges of implementing a new RTW program in an interorganisational setting.

### Methods:

The study was a randomized controlled trial with economic evaluation undertaken with workers on sick leave for 4–12 weeks due to MSDs. CTWR consists of a work disability screening by an interdisciplinary team followed by the collaborative development of a RTW plan. The primary outcome variable was registered cumulative sickness absence hours during 12 months follow-up. Secondary outcomes were work status as well as pain intensity and functional disability, measured at baseline, 3 and 12 months follow-up. The economic evaluation (intervention costs, productivity loss, and health care utilization costs) was based on administrative data derived from national registries.

### Results:

For the time intervals 0–6 months, 6–12 months, and the entire follow-up period, the number of sickness absence hours was significantly lower in the CTWR group as compared to the control group. The total costs saved in CTWR participants compared to controls were estimated at US \$ 1,366 per person at 6 months follow-up and US \$10,666 per person at 12 months follow-up.

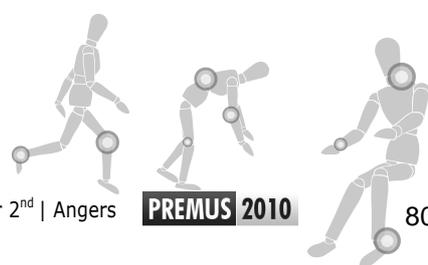
### Conclusion:

The findings of this study provide suggestive evidence that CTWR employed by an interdisciplinary team is (cost-) effective compared to conventional case management. Workers on sick leave for 4–12 weeks due to MSD who underwent “CTWR” by an interdisciplinary team had fewer sickness absence hours than controls. The economic evaluation showed that—in terms of productivity loss— CTWR seems to be cost saving for the society. Different challenges of implementing RTW programs at a large scale in interorganisational settings were identified, e.g., how to refer the right patients in the appropriate timeframe. Future studies should address interorganisational aspects when implementing RTW programs in different settings, e.g., insurance-, workplace-, social- or healthcare setting.

**Keywords:** Disability prevention, Economics, Back, low back.

### References:

- Loisel P, Durand M-J, Berthelette D, Vézina N, Baril R, Gagnon D.  
Loisel, P., Durand, M. J., Berthelette, D., Vézina, N., Baril, R., Gagnon, D., Larivière, C. et Tremblay, C., ‘Disability prevention - New paradigm for the management of occupational back pain’, *Disease Management & Health Outcomes* 9: 7 (2001), 351-360.  
Franche RL, Cullen K, Clarke J, Irvin E, Sinclair S, Frank J.  
Franche, R. L., Cullen, K., Clarke, J., Irvin, E., Sinclair, S., & Frank, J., (2005). Workplace-based return-to-work interventions: A systematic review of the quantitative literature. *Journal of Occupational Rehabilitation*, 15(4), 607-631.  
Anema JR, Steenstra IA, Bongers PM, de Vet HC, Knol DL,  
Anema JR, Steenstra IA, Bongers PM, deVet HCW, Knol DL, Loisel P, van Mechelen W (2007). Multidisciplinary rehabilitation for subacute low back pain: Graded activity or workplace intervention or both? *Spine*, 32, 291-298.



## LOW BACK PAIN: EFFECT OF WORK EXPOSURES, LIFESTYLE AND INDIVIDUAL FACTORS

### **Symposium Description**

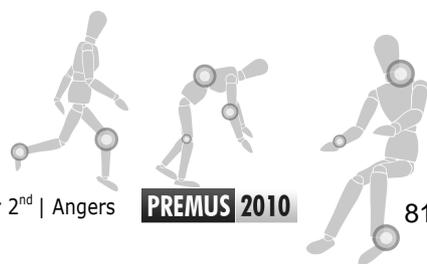
Increasing amount of evidence suggests that both individual and environmental risk factors play a role in the etiology of low back pain (LBP). However, the mutual interplay of these risk factors is not well understood. Efforts to accumulate data on determinants of LBP will not only aid in preventing major loss of working days/major economical losses but also in understanding the etiologies and pathomechanistic pathways likely to be shared by several chronic diseases.

### **Symposium Author**

Dr. Svetlana SOLOVIEVA

### **Authors linked to the Name of their abstract symposium**

SHIRI R.	Interrelationships between overweight, physical activity and low back pain
SOLOVIEVA S.	Does obesity cause low back pain?
HUNG Y.J.	The gene-work exposure interaction in causing lumbar herniated intervertebral disc (HIVD) in Taiwan



## INTERRELATIONSHIPS BETWEEN OVERWEIGHT, PHYSICAL ACTIVITY AND LOW BACK PAIN

SHIRI R.<sup>1</sup>, SOLOVIEVA S.<sup>1</sup>, HUSGAFVEL-PURSIAINEN K.<sup>1</sup>, TELAMA R.<sup>2</sup>, VIIKARI J.<sup>3</sup>, RAITAKARI O.T.<sup>4</sup>, VIIKARI-JUNTURA E.<sup>1</sup>

<sup>1</sup> Centre of Expertise for Health and Work Ability, Finnish Institute of Occupational Health, Helsinki, Finland - <sup>2</sup> LIKES Research Institute, Jyväskylä, Department of Sport Sciences, University of Jyväskylä, Finland - <sup>3</sup> Department of Medicine, University of Turku, and Turku University Hospital, Turku, Finland - <sup>4</sup> Department of Clinical Physiology, Turku University Hospital, and Research Centre of Applied and Preventive Cardiovascular Medicine, University of Turku, Turku, Finland

### Aims:

To assess the effects of overweight/obesity and physical activity/inactivity on the incidence of low back pain.

### Methods:

As part of the ongoing Young Finns Study, participants aged 24–39 years at baseline in 2001 were included. The effects of overweight/obesity and physical activity/inactivity on the incidence of low back pain were studied among 1224 subjects free from low back pain at baseline. Obesity was defined based on BMI and waist circumference. We defined a decrease or an increase in physical activity by at least two points change in the subject's physical activity index (range 5-15) during the follow-up.

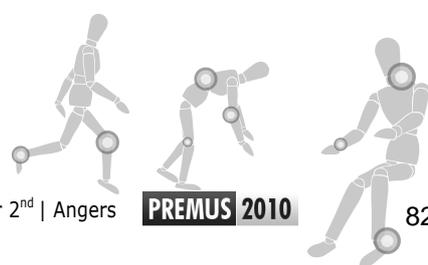
### Results:

Obesity at baseline doubled the incidence of radiating low back pain. Decrease in physical activity increased the incidence of non-specific low back pain (adjusted OR = 1.7, 95% CI 1.1-2.6). Obese subjects who reduced their physical activity were at highest incidence of non-specific (OR = 2.3, 95% CI 1.0-5.1) and radiating (OR = 2.7, 95% CI 1.1-6.6) low back pain compared with normal weight subjects who did not decrease their physical activity. Low back pain at baseline had no effects on either incident overweight or change in physical activity.

### Conclusion:

The associations between overweight/obesity and low back pain and between physical activity/inactivity and low back pain are unidirectional. Our findings suggest that obesity and a decrease in physical activity increase the risk of low back pain. Obese subjects who reduce their level of physical activity are at highest risk of low back pain. Weight loss and especially physical activity could reduce the risk of low back pain.

**Keywords:** Personal risk factors for MSD, Epidemiology, Back, low back.



## DOES OBESITY CAUSE LOW BACK PAIN?

SOLOVIEVA S., HUSGAFVEL-PURSIAINEN K., SHIRI R., VIKARI J., KÄHÖNEN M., RAITAKARI O.T., LEHTIMÄKI T., VIKARI-JUNTURA E.

*Centre of Expertise for Health and Work Ability, Finnish Institute of Occupational Health, Helsinki, Finland.*

### Aims:

The findings of a recent meta-analysis indicate that overweight and obesity increase the risk of low back pain (LBP). However, observational studies have limited ability to robustly identify causal associations due to many potential biases, confounding and reverse causation. Mendelian randomization analysis uses genetic variants with known functions as markers of long-term exposure to estimate un-confounded exposure–outcome associations in observational studies. The aim of this study was to examine the effect of obesity on LBP using Mendelian randomization.

### Methods:

As part of the ongoing Young Finns Study, a total of 1828 individuals (1034 women), aged 3-18 at study induction, took part in clinical examinations in 1980, 1983, 1986, 2001 and 2007. Weight-related measures across life span were classified into three groups using factor analysis. We examined the causality between obesity-related phenotypes (body mass index (BMI), waist circumference and weight-related score) and LBP using four FTO gene variants (rs9939609, rs1421085, rs9930506 and rs17817449).

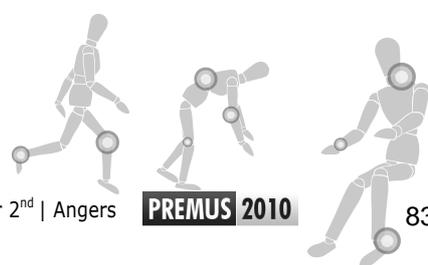
### Results:

All genotyped single nucleotide polymorphisms (SNPs) were consistently associated with obesity-related phenotypes, but not with other risk factors that might confound the association between obesity and LBP. The strongest associations were observed for the rs9930506 SNP. Gender-stratified ordinary logistic regression analysis suggested a positive association of adult BMI, waist circumference, life-time BMI and weight-related score with LBP in women and an inverse association of lifetime BMI with LBP in men. When examined using genetic variants as the instrument for lifetime BMI and weight-related score, there was an association between lifetime BMI and LBP in men and between weight-related score and LBP in women. A high weight-related score during 9-15 years of age increased the risk of LBP in adult women.

### Conclusion:

Results from Mendelian randomization strengthen the evidence of the causal effect of obesity during puberty on LBP in adult women.

**Keywords:** Personal risk factors for MSD, Epidemiology, Back, low back.



## THE GENE-WORK EXPOSURE INTERACTION IN CAUSING LUMBAR HERNIATED INTERVERTEBRAL DISC (HIVD) IN TAIWAN

HUNG Y.J., SHIH T.T.F., CHEN B.B., CHEN C.H., MA L.P., HWANG Y.H., YANG S.H., HSU H.C., WANG T.M., LIOU S.H., GUO Y.L.

*Institute of Occupational Medicine and Industrial Hygiene, National Taiwan University, Taiwan, ROC*

### Aims:

Herniated intervertebral disc (HIVD) is the most important occupational diseases among workers in Taiwan. Although both occupational and personal factors play roles in etiology of HIVD, genetic background might contribute to the susceptibility to HIVD. We conducted a hospital-based case-control study to examine the gene-work exposure interaction in causing HIVD.

### Methods:

One hundred and fifty patients with HIVD and 150 controls seen in the same hospital for upper respiratory infection were invited to the study. Every participant was assessed with questionnaire, Magnetic Resonance Imaging (MRI) and Bone mineral density (BMD) assessment, blood was donated by participants for genotype analysis. A detailed life-long work history was taken, including lifting, sitting, and standing. Photographs were taken for these postures, and 3 D Static Strength Prediction Program (3D SSPP) was used to estimate the load over intervertebral disc between the 4th and 5th lumbar vertebrates.

### Results:

A total of 168 subjects participated and satisfactorily completed the study measurements, and were entered for the final analysis. The result showed that HIVD are associated with older age, higher BMI, longer working tenure, higher education level, and single marital status. Life time cumulative load in L4-5 due to lifting were higher in HIVD cases as compared to the controls. While categorized into 3 groups, the highest cumulative lift load had increased odds ratio of 2.7 (95% CI 1.2-6.3) as compared to the lowest, after adjusted for age, gender, and BMI. Among these high lifting group, those with COL9A2 carrying a Trp allele seemed to have higher risk than those without a Trp allele ( $p=0.087$ ). Also, those with CT/TT genotypes of VDR gene had higher risk than those with CC genotypes ( $p=0.07$ ).

### Conclusion:

The result of the study suggested life time cumulated lifting load are associated with HIVD, showing a dose-response gradient. COL9A2 genotype with any Trp allele seemed to interact with lift load and played susceptibility factor among workers highly exposed to weight-lifting.

**Keywords:** Exposure measurement methods, Personal risk factors for MSD, Back, low back.

### References:

- Battie MC, Videman T. Lumbar disc degeneration: epidemiology and genetics. *J Bone Joint Surg Am.* 2006;88:3-9.  
Solovieva S, Lohiniva J, Leino-Arjas P, et al. COL9A3 gene polymorphism and obesity in intervertebral disc degeneration of the lumbar spine: evidence of gene-environment interaction. *Spine.* 2002;27(23):2691-6.  
Guo HR, Chang YC, Yeh WY, Chen CW, Guo YL. Prevalence of musculoskeletal disorder among workers in Taiwan: a nationwide study. *J Occup Health.* 2004;46:26-36.



## METHODS FOR RISK ANALYSIS IN PRACTICE

### **Symposium Description**

There is a broad range of methods that have been developed for the assessment of exposure to risk factors for work-related musculoskeletal disorders. These methods can be divided between self-reports from workers (interviews, questionnaires); observational methods using specifically designed pro-forma sheets or using advanced techniques developed for the assessment of postural variation; and direct measurements using monitoring instruments that rely on sensors (David 2005).

The choice between the methods available will depend upon the application concerned and the objectives of the study. General, observation-based assessments appear to provide the levels of costs, capacity, versatility, generality and exactness best matched to the needs of occupational safety and health practitioners who have limited time and resources at their disposal and need a basis for establishing priorities for intervention.

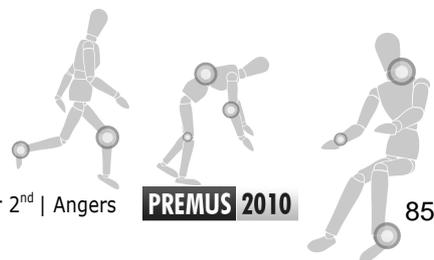
In this symposium, several of these observation-based practical methods will be presented. Each method will be presented in brief, followed by a discussion on validity and reliability and uniqueness of the method. Some of the methods are already in practice since years, whereas other ones received suddenly more attention e.g. during the European labour inspectorate (SLIC) campaign in Europe to tackle musculoskeletal disorders at work.

### **Symposium Author**

Mr. Alain PIETTE

### **Authors linked to the Name of their abstract symposium**

HERMANS PIETTE A.	V.,	Ergonomic risk analysis and global company OSH analysis
DOUWES M.		The hand arm risk assessment method (HARM), continued development
STEINBERG U.		The key indicator methods – status quo of a toolbox for risk assessment of physical workload on a screening level
GRAY M.I.		Promoting compliance with the european directive on manual handling – the use of the manual handling assessment charts (MAC) by regulators and duty holders
FERREIRA J.J.		A practical inspection tool for assessment of repetitive tasks of the upper limbs (ART)
WATERS T.		Update on the revised NIOSH lifting equation



## ERGONOMIC RISK ANALYSIS AND GLOBAL COMPANY OSH ANALYSIS

HERMANS V.<sup>1</sup>, PIETTE A.<sup>2</sup>

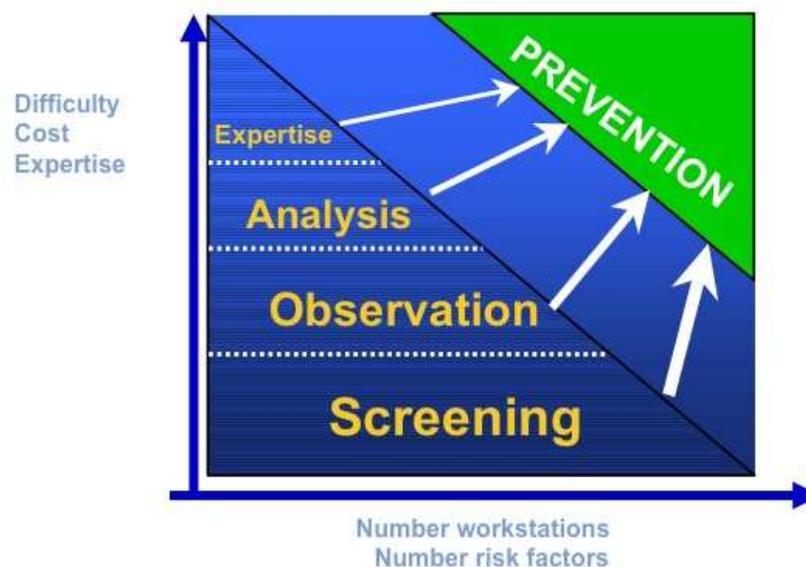
<sup>1</sup> Vrije Universiteit Brussel and IDEWE, Belgium – <sup>2</sup> Federal Public Service Employment, Labour and Social Dialogue, Belgium

### Aims:

This presentation is the introduction of the symposium on ergonomic physical risk analysis methods. The aim of the introduction is to discuss in brief the relation between an ergonomic physical risk analysis and a global company health and safety analysis. How can these analysis be integrated?

### Results:

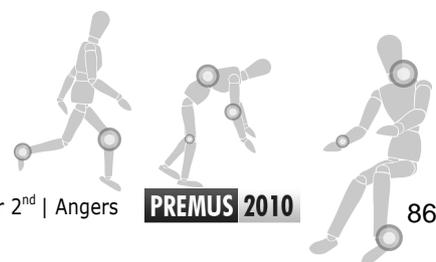
Many companies consider ergonomics to be a part of safety and health, which focuses in the first place mainly on the reduction of risks. Ergonomics is often implicitly present in risk analysis, although on a very rough base. Also, often very specific physical risk analysis is performed, without relation to the global company risk analysis. Therefore, ergonomics is often considered as a one-time shot instead of a continuous to be improved initiative. Recently, this problem has been tackled by the SOBANE strategy, a strategy to coordinate cooperation between all levels in a company regardless of the prevention domains. It includes safety, health, ergonomics, industrial hygiene, milieu and psychosocial issues related to work. By working with SOBANE, a real integration of all the OSH disciplines is possible. The method starts with a participatory screening of risks (called Déparis) which systematically reviews all aspects concerning the ease, the effectiveness and satisfaction at work. The process does not stop at the stage of problem analysis, since possible solutions are asked from the workers, discussed with management and prevention officers. Also specific further planning is drawn up. When difficult problems have to be tackled and/or no solutions are immediately found, a further observation and analysis of the risks is necessary. For this analysis, specific methods have to be used. E.g. for manual handling problems or repetitive work, risk analysis using specific methods have to be made. The methods presented in this symposium are examples of these analysis methods.



**Keywords:** Postures, physical exposure, Exposure measurement methods, Other.

### Reference:

[www.sobane.be](http://www.sobane.be)



## THE HAND ARM RISK ASSESSMENT METHOD (HARM), CONTINUED DEVELOPMENT

DOUWES M., DE KRAKER H.

TNO Quality of Life, Hoofddorp, The Netherlands

### Aims:

A practical tool was developed for risk assessment of developing complaints of the arm, neck or shoulders during manual tasks. This tool, named 'Hand Arm Risk assessment Method' (HARM), is freely available as both paper and web application and can be used by any organization, without training or ergonomic expertise. In this paper the development of the tool from 2007 up till now and plans for the future will be described.

### Methods:

In 2007 we started the development by defining risk factors from epidemiological studies. Then we studied existing methods and compared them to the criteria we had defined. The Key Indicator Method for Manual Operations (KIM MO) of Steinberg et al. (2007) met our criteria best. Based on literature and expert opinions adjustments were made to the KIM MO, mainly to elaborate the postural factors. The first paper prototype of the tool was tested in ten companies, improved and transformed into a web application.

In 2008 we tested the inter tester reliability and the (concurrent) validity of the tool. For this study we compared the results of HARM when used to evaluate five tasks by 11 users from companies with the results of HARM when used by experts, who actually measured the risk factors. The reliability was tested by comparing the results of the 11 users.

### Results:

The validity and reliability results varied between tasks and were used to improve the tool. Some results indicated that more explanation was needed for the user of HARM. Therefore, we developed an instruction video (in 2009). This video was developed by a professional director and actors. In the video the overall purpose of the method and all steps are clearly explained, using three different tasks as an example. It also shows how to collect the data that are needed and how to fill in these data in the tool.

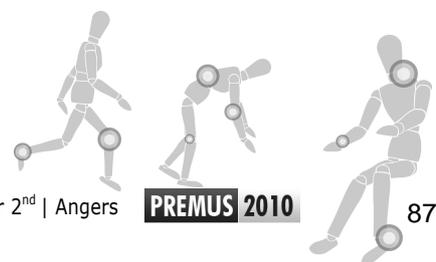
### Conclusion:

The HARM appears to serve its purpose well and has therefore been made available to all companies. In 2011-2014 the predictive validity of the improved tool will be studied. Moreover, an implementation plan will be developed for all tools that are available and feedback from companies and occupational health officers in the field who have used the method will be collected and studied to improve the contents and usability.

**Keywords:** Exposure measurement methods, Early prevention.

### Reference:

Steinberg U, Behrendt S, Caffier G, Schulz K and Jakob M. Leitmerkmalmethode Manuelle Arbeitsprozesse-Erarbeitung und Anwendungserprobung einer Handlungshilfe zur Beurteilung der Arbeitsbedingungen. Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Berlin, 2007 (Confidential, Report in German).



## THE KEY INDICATOR METHODS – STATUS QUO OF A TOOLBOX FOR RISK ASSESSMENT OF PHYSICAL WORKLOAD ON A SCREENING LEVEL

STEINBERG U., LIEBERS F.

Federal Institute for Occupational Safety and Health (BAuA) Unit 3.1 "Prevention of work-related disorders" Nöldnerstraße 40-42 / D-10317 Berlin, Germany

### Aims:

The objective of the Key Indicator Methods (KIM) is to provide a toolbox for risk assessment of the most common forms of physical work. The development of KIM for manual handling of loads was carried out with special reference to Directive EEC 269/90 in 1995 and 1999. Three KIM were developed: (i) lifting, holding, and carrying, (ii) pushing and pulling, (iii) manual operations (draft). In order to involve all stakeholders on an equal footing they are designed for practitioners without specific ergonomic training. It is intended that the KIM are applied on a screening level. The probability of overload to the musculo-skeletal system is indicated – not its severity or localisation. Three steps are integrated in the tools: risk identification, screening, and tackling special problems by time, motion, and force study

### Methods:

The scientific background is based on internationally published literature and methods, particularly the NIOSH-equations, the Job Strain Index, the Occupational Repetitive Actions Risk Index, the Hand Activity Level, and several biomechanical model calculations. The evaluation model generally takes into account four factors: biomechanics, muscular-metabolic effort, acting dose, and individual variations. This basis model for evaluation is adopted for the three KIM with specific focus on mechanically stressed body regions and different biological effects. The KIM have been tested methodologically.

Risk assessment is carried out in two steps. The first step is to estimate each key indicator individually. The second step is the calculation of a total score by multiplying the sum of the key indicator rating points by a time rating point.

### Results:

In the beginning of 2010 the KIM are widely in use in Germany and in other countries, both in the original as well as in numerous adopted methodological versions. They are considered by many practitioners as a support tool for their professional expertise. The main application areas are risk assessment, job design, and workplace health promotion.

### Conclusion:

Over ten years many practical experiences, questions and user suggestions have been collected. In response an adjustment of KIM lifting, holding, and carrying and KIM pushing and pulling with the focus on the extension of scales, specification of instructions for use and connection to methods of industrial engineering will be carried out in 2010 and 2011. The development and testing of the draft of the KIM "manual operations" will be finished in 2010.

**Keywords:** Biomechanics, Postures, physical exposure, Exposure measurement methods

### References:

- Steinberg U, Behrendt S, Bradl I, Caffier G, Gebhardt H, Liebers F et al. Erprobung und Evaluierung des Leitfadens Sicherheit und Gesundheitsschutz bei der manuellen Handhabung von Lasten. 2000; Bremerhaven: Wirtschaftsverl. NW. Schriftenreihe der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin: Forschung, Fb 897
- Steinberg U, Caffier G, Liebers F. Assessment of Manual Material Handling based on Key Indicators – German Guidelines. In: Handbook of Standards in Ergonomics and Human Factors. Ed. by W. Karwowski. Lawrence Erlbaum Associates. Mahwah, New Jersey, London 2006; p319-338
- Caffier G, Steinberg U, Liebers F, Behrendt S. Guide for risk assessment in repetitive handling tasks - substantiation of hypotheses and development of a practice-based approach. In: PREMUS 2007. Sixth International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders, Boston, Massachusetts, USA, 27-30 August, 2007. Book of Abstracts. 2007; p308



## PROMOTING COMPLIANCE WITH THE EUROPEAN DIRECTIVE ON MANUAL HANDLING – THE USE OF THE MANUAL HANDLING ASSESSMENT CHARTS (MAC) BY REGULATORS AND DUTY HOLDERS

GRAY M.I., MONNINGTON S.C., QUARRIE C.

*Health and Safety Executive, Human Factors, Ergonomics and Psychology Specialist Team, Sheffield, UK*

### **Aims:**

To assist Health and Safety Inspectors and employers in identifying high risk workplace manual handling activities the Manual handling Assessment Charts (MAC) were developed by the UK's Health and Safety Executive (HSE). This paper describes how the MAC tool has been used in the UK to provide practical assistance with meeting the requirements of the European Manual Handling directive.

### **Methods:**

MAC has been developed as a simple colour coded semi-quantitative approach to manual handling risk assessment. Its development is described in Monnington et al (2002). Training for inspectors, employers and trades unions since its development has helped to promote its use. Materials are also made available on the HSE website ([www.hse.gov.uk/msd/mac](http://www.hse.gov.uk/msd/mac)) to support people in the use of the tool.

In addition guidance has been produced to help inspectors and others consider how enforcement should be considered in the light of MAC outputs. The aim is to ensure consistent and defensible decisions on when enforcement action should be considered. (HSE 2006).

### **Results:**

Many companies have found that MAC has provided them with a convenient and reasonably simple means of considering their manual handling tasks. Where concerns have been raised by inspectors or the workforce MAC has been useful in highlighting those risk factors which need most prompt attention

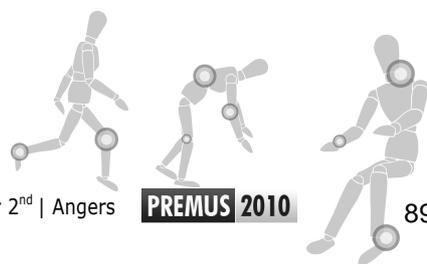
### **Conclusion:**

The use of the MAC in the UK has helped duty holders to identify risks associated with manual handling tasks and prioritise actions to control these risks. Regulators have also been able to use the tool to demonstrate the effectiveness of control measures in reducing the overall risk of injury. In some cases MAC has been used to support enforcement action in the courts but in many cases its use is sufficient to show duty holders how to take practical steps to ensure compliance with the law.

**Keywords:** Postures, physical exposure, Exposure measurement methods, Intervention methods

### **References:**

Monnington SC, Pinder ADJ, Quarrie C Development of an inspection tool for manual handling risk assessment, Health and Safety Executive 2002 [http://www.hse.gov.uk/research/hsl\\_pdf/2002/hsl02-30.pdf](http://www.hse.gov.uk/research/hsl_pdf/2002/hsl02-30.pdf)  
Health and Safety Executive Manual Handling Assessment Charts, MAC, and EMM Operational Circular OC 313/4 HSE 2006 [http://www.hse.gov.uk/foi/internalops/fod/oc/300-399/313\\_4.pdf](http://www.hse.gov.uk/foi/internalops/fod/oc/300-399/313_4.pdf)



## A PRACTICAL INSPECTION TOOL FOR ASSESSMENT OF REPETITIVE TASKS OF THE UPPER LIMBS (ART)

FERREIRA J.J., GRAY M.I., BIRTLES M.

Health and Safety Laboratory, Buxton, Derbyshire, UK

### Aims:

While several methods exist for analysing the frequent handling of light loads and other repetitive tasks, only a small group of ergonomics and occupational health professionals within Great Britain (GB) use these methods in practice. The aim was to develop a practical tool that GB Health and Safety Inspectors could use in the workplace to screen repetitive tasks for significant risks of work-related upper limb disorders (WRULD).

### Methods:

Initial development focussed on simplifying and reformatting the Occupational Repetitive Actions (OCRA) checklist (Colombini et al., 2002), and ensuring consistency with existing HSE (2002) guidance on WRULD risk assessment. Technical aspects of the tool were examined during repeated peer review workshops, as well as a benchmarking exercise to compare assessment results to those obtained with the Strain Index, OCRA checklist and Quick Exposure Check (QEC). The usability of the tool was refined through iterative user trials and a field-based pilot involving 93 Inspectors.

### Results:

A practical paper-based tool was developed for GB Inspectors to use in the workplace to assess repetitive tasks of the upper limbs. The tool examines twelve risk factors grouped into four stages: frequency and repetition of movements; force; awkward postures; and additional factors, which include aspects of duration and recovery. The Assessment of Repetitive Tasks (ART) tool has been well received by Inspectors who have been trained to use it in the workplace. Specific features reported to improve the usability of ART were:

- a flowchart structure to set out the risk factors in a clear sequence, and which helps Inspectors to demonstrate the assessment process to employers;
- a qualitative colour coded approach (green/amber/red) to identify the significant risks and where to focus risk reduction measures;
- a simple scoring system to help prioritise tasks for improvement;
- a method to take account of task rotation as a means of risk reduction.

Training and regular use is required for Inspectors to use ART reliably. Online tuition material allows users to view videos and practice assessing tasks before applying ART at a workplace. A team of ergonomics specialists is available to advise users when required.

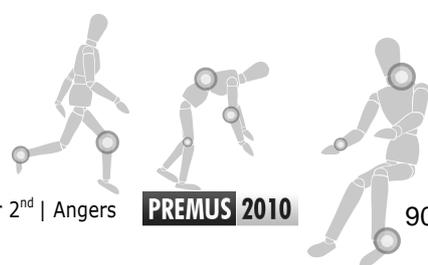
### Conclusion:

Health and Safety Inspectors can help ensure that the risks of repetitive tasks are identified within premises that have not considered ergonomics risk assessments previously. To achieve this, Inspectors require methods such as ART that are easy to use in practice and help identify the significant risks

**Keywords:** Postures, physical exposure, Intervention methods, Upper limb.

### References:

Colombini, D., Occhipinti, E., and Grieco, A. Risk assessment and management of repetitive movements and exertions of upper limbs: job analysis, OCRA risk index, prevention strategies and design principles, Oxford: Elsevier Science 2002.  
Ferreira, J., Gray, M., Hunter, L., Birtles, M., Riley, D. Development of an assessment tool for repetitive tasks of the upper limbs (ART). Sudbury: HSE Books; 2009. Research report 707.  
Health and Safety Executive (HSE). Upper limb disorders in the workplace. Sudbury: HSE Books; 2002. HSG60 second edition



## UPDATE ON THE REVISED NIOSH LIFTING EQUATION

WATERS T.R.

*National Institute for Occupational Safety and Health*

### Aims:

Background - Historically, NIOSH has recognized the problem of work-related low back disorders (LBDs) resulting from manual lifting. In response, NIOSH published the Work Practices Guide for Manual Lifting (WPG) in 1981. The 1981 lifting equation has been used throughout the world as a tool for assessing manual lifting jobs. In 1993, NIOSH modified the equation and published the Revised NIOSH Lifting Equation (RNLE). The rationale and criterion for the development of the revised NIOSH lifting equation (RNLE) are provided in a journal article by Waters et al. [1].

### Methods:

Recent Modifications - The original RNLE contained procedures for assessing single and multi-task manual lifting jobs, but recently NIOSH researchers have developed two additional procedures – the Sequential Lifting Index [2] and Variable Lifting Index [3] – that allow the assessment of lifting jobs performed in sequence, such as during job rotation, and in conditions where the task characteristics vary from lift to lift, such as in a warehousing.

### Results:

Validity and Reliability - Several studies have examined the effectiveness of the Revised NIOSH Lifting Equation (NLE) to identify jobs with increased risk of low back disorders. In one study, researchers showed that as the lifting index (LI) increased from 0.0 to 3.0, the odds of low back pain increased significantly. In another study of lifting-related MSDs in the metal processing industry the authors found that the RNLE was effective in identifying jobs with high risk for LBP. In yet another study, the authors found that when the maximum horizontal distance was used in the LI calculation, the odds ratio for high risk compared to low risk jobs was 4.3. In still yet another study, researchers found no significant differences between the NIOSH recommended weights of load and the psychophysically determined maximum acceptable weights of lift. The authors concluded that the NIOSH weight limit equation is well suited for young, healthy Korean males. Other researchers showed that the Recommended Weight Limit (RWL) likely would protect about 85% of the female population and 95% of the male population. In another epidemiological study, researchers found that the lifting index is reliable in assessing the potential risk of low-back injury in MMH.

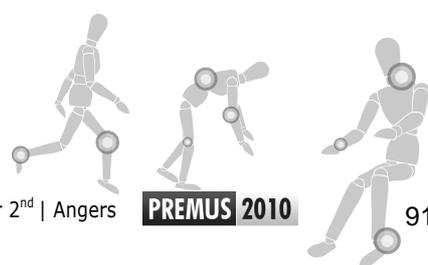
### Conclusion:

The recommended weight limit (RWL) derived from the RNLE is consistent with, or lower than those generally reported in the literature [1]. The new SLI and VLI will expand the scope of application for the RNLE.

**Keywords :** Postures, physical exposure, Exposure measurement methods, Back, low back.

### References:

- [1] Waters T.R., Putz-Anderson V., Garg A., and Fine L.J., Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics*. 1993, 36(7), 749-776.
- [2] Waters T.R., Lu M.L., and Occhipinti E. New procedure for assessing sequential manual lifting jobs using the revised NIOSH lifting equation. *Ergonomics*. 2007, 50(11): 1761-1770.
- [3] Waters, T.R., Occhipinti E., Columbini, D., Alvarez, E., and Hernandez, A. The variable lifting index (VLI): a new method for evaluating variable lifting tasks using the revised NIOSH lifting equation, Proceedings of the 2009 IEA Conference, Beijing, China, August 2009.



## ROUND TABLE: MOBILIZATION/PARTICIPATION OF STAKEHOLDERS FOR SUSTAINABLE MSD PREVENTION

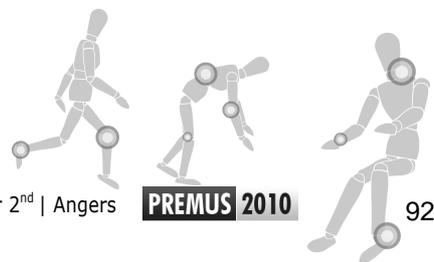
Some studies show that the mobilization and involvement of company stakeholders are an important ingredient for prevention to be integrated into the company's operation and for actions to be sustainable over time. This observation is in line with the concerns of participatory ergonomics, whose objective is to improve the effectiveness of projects on prevention and design. In the context of this symposium, we would like to explore the strategies and impediments of several stakeholders in the company based on the activity analysis. This will raise a few questions: How can they mobilize themselves even more? What are the means on which the ergonomist can act to facilitate this stakeholder mobilization (training, development of intervention tools, collective activity)? In what way does a focus on stakeholders renew participatory ergonomic intervention processes on design and prevention?

### **Symposium Author**

Dr. Sandrine CAROLY

### **Authors linked to the symposium**

<b>Authors linked to the symposium</b>	<b>Name of their abstract</b>
WELLS R.	Challenges and facilitators for workplace change using participative ergonomics
SAINT VINCENT M.	Follow-up of MSD prevention interventions initiated by work inspectors: process and impacts
CAROLY S.	Developing the collective activity conditions of occupational health physicians for promoting multidisciplinary in MSD prevention
DUGUE B.	Action-training of worker representatives: a contribution to prevention of work-related diseases
NASTASIA I.	Integration of ergonomics in a continuous improvement approach: goals and involvement of the main stakeholders
BELLEMARE M.	Prevention of MSDs: how OHS practitioners use their resources to become political navigators and improve work situations



## CHALLENGES AND FACILITATORS FOR WORKPLACE CHANGE USING PARTICIPATIVE ERGONOMICS

WELLS R.

*University of Waterloo, Ontario, Canada.*

### **Aims:**

Where evaluations of participative ergonomics (PE) interventions have been performed, mixed results have been reported. This paper reports on challenges and facilitators to PE interventions.

### **Methods:**

In a multiple case study of four worksites addressing musculoskeletal disorders (MSDs) in different companies using a quasi-experimental approach, we examined process, implementation, and a range of outcomes. The process evaluation was based upon fieldwork and interviews with approximately 90 persons. Implemented changes were documented by PE teams and intensity judged by the research team and the outcomes by questionnaire and assessment among cohorts present both before and after the changes (Wells et al., 2010; Cole et al., 2010).

### **Results:**

The teams each introduced between 10 and 21 changes over 10-20 months of activity. Only a small number of positive effects on physical effort and pain were discernible. Six interlinked issues that affected the activities of the PE were uncovered: theory vs. practice failure, revolutionary vs. evolutionary change, high vs. low capital cost settings, competing demands in the organization and institutionalization.

### **Conclusion:**

Program "failure" or deficit comes about when the intervention is not implemented as planned. A theory deficit occurs if the theoretical underpinnings are judged wanting. We observed aspects of both.

PE teams faced challenges securing employees' time, varying management commitment and significant production pressures; "ergonomics is on the plate. But it's not the meat, it's the vegetables". The lack of institutionalization was a severe handicap. Teams with an exclusive 'ergonomics' focus have been reported to be short lived and disappeared quickly after low hanging fruit had been addressed. This was our experience. In a separate setting, "goal hooking" aligned a PE team with quality and cellular manufacturing efforts, legitimizing its activities and potentially its sustainability.

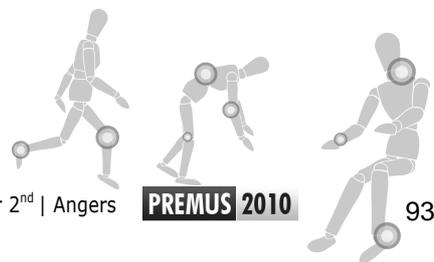
The changes introduced by the PE team were evolutionary rather than revolutionary leading, in the cases reported here, to limited exposure reductions. This in turn was consistent with the lack of discernible effects on physical effort or pain among the employees. The small changes could be partially due, in two sites, to the high capital cost environment where the production system itself was the source of the dominant exposures (Wells et al, 2009). Despite the challenges described, the companies', and especially worker's evaluations, were positive.

**Keywords:** Intervention studies, Intervention methods.

### **References:**

Cole D, Theberge N, Dixon S, Rivlis I, Neumann W. and Wells R. Reflecting on a program of participatory ergonomics interventions: a multiple case study. *Work* 2009; 34:161-178.

Wells R, Laing A, Cole D. Characterizing the intensity of ergonomics interventions for the prevention of musculoskeletal disorders, *Work* 2009; 34:179-194.



## FOLLOW-UP OF MSD PREVENTION INTERVENTIONS INITIATED BY WORK INSPECTORS: PROCESS AND IMPACTS

ST-VINCENT M., IMBEAU D., DENIS D., GONELLA M., COLE D.

*IRSST, Montréal, Canada*

### **Aims:**

Recently, the CSST established a program for MSD prevention. Inspectors check for the presence of risk factors at targeted workstations by using the QEC tool. If a risk exists, they require the company to implement corrective measures. The company is free to choose the intervention coordinator and the intervention approach. The aim of the study was to conduct a pilot project to evaluate the inspectors' interventions and also to establish the methodological foundations that would allow follow-up to be carried out on a larger sample.

### **Methods:**

Follow-up was carried out on eight work situations. Two major types of data were collected. Evaluation of the risk factors was done before and after the implementation of corrective measures at the targeted workstations using ten well-known methods. Case studies to describe the intervention and its results were also carried out by means of interviews with the actors involved in the intervention. A conceptual framework of the intervention identified the variables to be described: the company context; the intervention coordinator; the intervention process; the work situation analyzed as well as its main difficulties; and the changes made and the results obtained in the work situation, and more generally in the company.

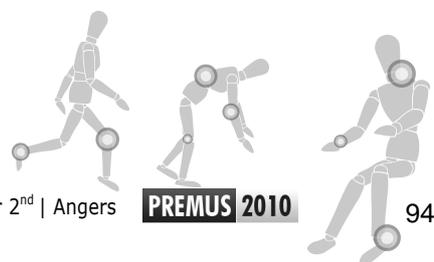
### **Results:**

In six of the eight cases followed, corrective measures were implemented. The companies called on an ergonomics expert in only one case. In the six cases, various significant changes were implemented. The transformations were assessed as sufficiently or very satisfactory. In four cases, the risk factors were reduced according to the quantitative methods. In all cases, productivity and quality were improved. Also noted were more general impacts on labour relations, the involvement in prevention, and the understanding of MSDs.

### **Conclusion:**

It seems that the conceptual framework and the tools developed allow proper follow-up of the interventions. One strong point in the study is the combination of quantitative data on the risk factors and perception data collected in the case studies. Three factors could have overestimated the results. These were large-size companies with a favourable context, the inspectors were selected, and the tasks analyzed were repetitive, and therefore less complex than varied tasks. In conclusion, this study suggests that the inspectors' interventions have positive impacts. For a more definitive conclusion, a broader study is needed.

**Keywords:** Postures, physical exposure, Intervention studies, Intervention methods.



## DEVELOPING THE COLLECTIVE ACTIVITY CONDITIONS OF OCCUPATIONAL HEALTH PHYSICIANS FOR PROMOTING MULTIDISCIPLINARITY IN MSD PREVENTION

CAROLY S., PIETTE A.

PACTE, University of Grenoble, France- SPF Emploi, Travail et Concertation sociale, Belgique

### Aims:

The occupational health physician is one of the major actors in MSD prevention. But we don't know really their practices, which are hidden by the professional secret of medical data. The stake is to take into account the occupational health physician's activity to develop their skills and to define their roles in pluridisciplinary intervention of MSD prevention.

### Methods:

The comparison between two studies can improve the understanding about their activity:

- The Belgian ministry of work (FPS) has funded a research with the national association of occupational physician which 450 physicians participated large online questionnaire
- According to the ANR (National Ministry of Research) program in France, the second study concerning 51 occupational physicians reports on the results of 35 days of ergonomic observations and 68 interviews.

### Results:

The first study in Belgium shows that:

- 98.6% health physician's face with MSD problems but only 40% are associated to the workplace analysis concerning prevention. The MSD problems are also taken into consideration by the occupational physician (96.4%) for the health surveillance for work with VDU.
- Concerning multidisciplinary collaboration, more than 90% are convinced of its "plus-value, 72% have frequent collaboration with other prevention advisers. 64% think that the internal prevention adviser is the priority actor to coordinate multidisciplinary approaches. 53% think that the priority actor is them.

The second study in France shows that:

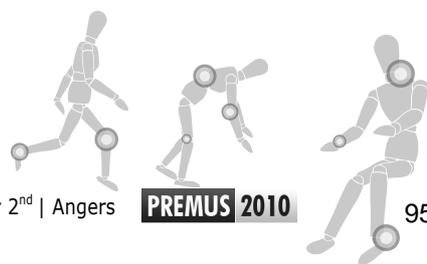
- During the medical visit, the occupational health physician achieves a real action of MSD prevention. But they don't have awareness of skills and have difficult to communicate over these actions with partner's stakeholders.
- The aim of their action is to create relevance and consistency between different domains of their activity (personal meeting with employee, relationship with direction and interaction with other stakeholders). To obtain efficiency in occupational health project, they analyse in the company the working conditions to preserve employee health and create an opportunity to link production management with prevention management and personal project, when it's possible.
- Their usual tools don't help them to develop action for MDS prevention.

### Conclusion:

The results of two studies improve the multidisciplinary collaboration by initiating actions:

- to better inform about what means an ergonomic approach
- to improve the collaboration between consulting physician and occupational physician for revalidation and return to work of MSD workers.
- to develop the legal missions of occupational physician to prevent MSD.

**Keywords:** Intervention studies, Intervention methods, Social aspects of MSD.



## **ACTION-TRAINING OF WORKER REPRESENTATIVES: A CONTRIBUTION TO PREVENTION OF WORK-RELATED DISEASES**

DUGUE B., PETIT J.

*Ergonomics Department, Ecole Nationale Supérieure de Cognitique - IPB, 33076 Bordeaux, France*

### **Aims:**

To guarantee a multi-factorial approach, the mobilization of all the actors of a company is an essential condition for the prevention of occupational diseases. The worker representatives are some of them. But trade-union members often have a normative approach of health issues at work. The respect of law can be their main topic of action.

It seems necessary to make them understand the trade-offs which workers operate in their work between the intent to make quality work and the attempt to preserve their health. This requires to detect what is pathogenic as well as what can represent a resource for action. It must help them to involve the workers in the analysis of the workplace as well as in the working out of change proposals. That requires to modify the trade unionists' view of work and to anchor their practice in a field-work, closer to the workers they represent.

### **Methods:**

We carried out during 18 months an action-training about occupational health for 22 trade-union teams. The goal was to give them a broader capacity of analysis and action. The action was organized with an alternation between six periods of group work with sharing of knowledge and field practices during which the teams were to analyze a work situation in order to formulate change proposals.

### **Results:**

The process of transforming work representations and trade union practices is difficult and takes time. The work carried out shows that it is not easy to resist common and preliminary interpretations of work-related diseases. But the 22 teams managed to bring precise analysis of the working conditions and the consequences on the workers' health. They could often work with the occupational physician of the company. It was more difficult to have a positive negotiation with the employers. But maybe the main result was that they involved the employees in their action, from the analysis of the problems to the construction of solutions. What is at stake is to switch from trade unionism for the employees, to trade unionism with the employees.

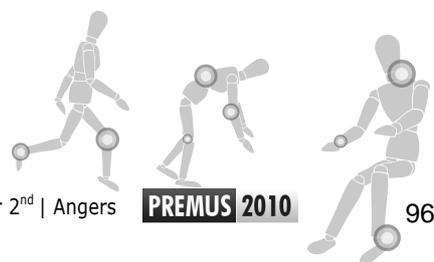
### **Conclusion:**

Following this action, we have set up three other action-training interventions with worker representatives, for more than one year each. To improve work-related disease prevention, we think it is necessary to develop action-researches with field actors, as well as research programmes concerning trade unionists' activity, as a part of prevention improvement programs.

**Keywords:** Early prevention, Intervention methods, Other

### **Reference:**

Théry L (Ed). Le travail intenable. Paris: La Découverte; 2006.



## INTEGRATION OF ERGONOMICS IN A CONTINUOUS IMPROVEMENT APPROACH: GOALS AND INVOLVEMENT OF THE MAIN STAKEHOLDERS

NASTASIA I., TOULOUSE G., ST-VINCENT M.

*Institut de recherche Robert-Sauvé en santé et sécurité de travail, Montréal, Canada.*

### **Aims:**

Achieving Competitive Excellence (ACE), a continuous improvement program initially developed in a large enterprise from the aviation sector in Quebec in order to provide powerful strategies and tools for achieving better results, was recently adapted to small and medium enterprises (SME) from the manufacturing sector. An ergonomic component was incorporated in order to impact productivity, quality and workers' health and safety (H&S). The purpose of this article is to describe the stakeholders' involvement in the implementation of the program and to reveal the major obstacles and conditions for the integration of ergonomic issues.

### **Methods:**

Global observations upon six major variables intervening in the process of the program implementation (protocol, context, actors, changes, tools, outcomes), and interviews with stakeholders were realised in four middle facilities of a same large manufacturing enterprise in Quebec. The main actions of the business management, challenges faced by the program's managers and change's agents, supervisors' reactions and workers' leeway in the process of implementation were described through qualitative analysis. The impact on H&S outcomes will be discussed in terms of main obstacles and successful conditions for the integration.

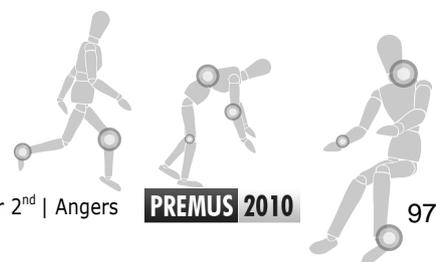
### **Results:**

Analysis allowed pointing out the role of stakeholders' actions on the integration of ergonomics into the program. The major obstacle was related to the constant migration of the key actors inside, outside and between facilities, and was caused both by economic context and by choices of the management. The dilution of ergonomic and continuous improvement's expertise through the different steps of the implementation had an important impact on the observed outcomes. Conditions for a more successful integration of ergonomics include real participation of workers in the process of implementation and factual efforts in transferring and keeping the actors' expertise related to the continuous improvement and integration principles.

### **Conclusion:**

Durability of the expertise seems to be one of the essential elements to be taken into consideration through the implementation's actions in order to insure the positive impact of the continuous improvement program not only upon productivity and quality outcomes, but also concerning workers' health and safety. Stakeholders should make particular efforts to integrate ergonomic issues at the different levels of the implementation of continuous improvement programs by maintaining the ergonomic expertise. Results also provide additional understanding of the importance of the contextual environment on the integration of ergonomic preoccupations through the stakeholders' actions.

**Keywords:** Work organization, Intervention studies, Intervention methods.



## PREVENTION OF MSDS: HOW OHS PRACTITIONERS USE THEIR RESOURCES TO BECOME POLITICAL NAVIGATORS AND IMPROVE WORK SITUATIONS

BELLEMARE M., BARIL-GINGRAS G., LE CAPITAINE C., ROSS J., POULIN P.

*Département des relations industrielles, Université Laval, Québec City, Canada.*

### Aims:

Work related musculoskeletal disorder prevention necessitates the identification, elimination or control of biomechanical factors (like postures, repetitiveness, duration, pressures exerted on tissues) as well as of psychosocial factors. To act on these factors, changes are to be made to the working situation: tools, layout, work organization, etc. OHS consultants must thus act as « political navigators » (Broberg and Hermund, 2004), doing « organizational work » (Theberge et al. 2008). In a research conducted with a group of OHS practitioners, we collected data describing this part of their work, based on a conceptual model of the intervention (Baril-Gingras et al. 2004) which highlights its socio-organizational aspects. This article presents some principles used by practitioners.

### Methods:

27 interventions were analysed, conducted in various workplaces by 11 OHS practitioners from joint sector-based OHS associations and public OH teams. Two sources of data were used: 1) a preformatted log book held by each of them 2) individual semi-structured interviews. Principles of action were extracted from these data and discussed in 3 audio-taped meetings, the final principles resulting of that iterative validation.

### Results:

During the intervention, practitioners identify stakeholders' preoccupations, using it, if favourable, to reach OHS objectives, or reflecting on ways to overcome obstacles. Through different activities (meetings, training sessions, etc.) they look for support from the different key players. For example, high management can be convinced by examples of concrete solutions in other workplaces; support from supervisors can be obtained by demonstrating how work situations at risk for MSD are often affected by production problems such as lack of quality, increased delays and staff turnover; implication of supervisors in training activities about MSD prevention is used as a mean to increase their support; workers must also be convinced that the modified work situation will still allow them to achieve production objectives; their input (brain storming, prototype try out) will be negotiated as a key principle for a lasting prevention; workers unions preoccupations, like employment and workload, have to be understood, etc. Putting into practices these principles depend on the practitioners' resources: e.g. mandate, time, credibility, possibilities of exchange with colleagues, orientations and support from their organization, legal requirements.

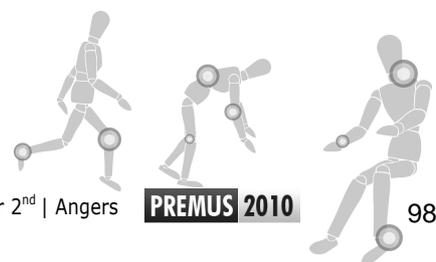
### Conclusion:

There is a need to systematize the gathering of information on the socio-organizational aspects of interventions and on the resources practitioners use and need. This may inspire public policy. Further analyses could concentrate on the link with lasting prevention.

**Keywords:** Early prevention, Intervention studies, Social aspects of MSD.

### References:

- Theberge, N. , Wells, R. Tizneem Nagdee, T. and P. Neumann. 2009. "Doing "Organizational Work": Expanding the Conception of Professional Practice in Ergonomics". Proceedings of the 40th conference of Association of Canadian Ergonomists. Québec city: Cederom, ISBN 978-0-9732384-8-8.
- Broberg O. and Hermund I. 2004. The OHS Consultant as a « Political reflective Navigator » in Technological Change Processes. International Journal of Industrial Ergonomics, 33:315-326
- Theberge N. Wells R. Tizneem Nagdee T. and P. Neumann. 2009. "Doing "Organizational Work": Expanding the Conception of Professional Practice in Ergonomics". Proceedings of the 40th conference of Association of Canadian Ergonomists. Québec city: Cdrom, ISBN 978-0-9732384-8-8.



## MULTISITE PAIN: RISK FACTORS AND CONSEQUENCES FOR WORK ABILITY

### **Symposium Description**

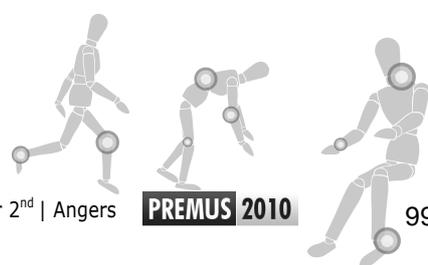
Concurrent pain at multiple body sites is highly prevalent in the working-age population. Multisite pain is associated with decreased quality of life and functioning. Some recent studies implicate that the adverse consequences of multisite pain for work ability are more severe than those of pain in a single body site. More information is needed on sickness absence and permanent work disability connected with multisite pain. For preventive purposes, knowledge on work-related and other modifiable determinants of multisite pain is essential, but is at present incomplete. There is today no consensus on the definition of multisite pain: some authors make use of published criteria for widespread pain, others use a simple count of painful sites, the cut-off point of which varies between studies.

### **Symposium Author**

Dr. Päivi LEINO-ARJAS

### **Authors linked to the symposium**

<b>Authors linked to the symposium</b>	<b>Name of their abstract</b>
KARPPINEN J.	Prevalence of multisite pain, their determinants, and impact on health-related quality of life among Finnish young adults
HAUKKA E.	Reciprocal associations of psychosocial factors at work with multisite musculoskeletal pain: a two-year follow up study among kitchen workers
NATVIG B.	Multisite pain: risk factors and consequences for work ability
KÄÄRIÄ S.	Low back pain, neck pain and their co-occurrence as predictors of sickness absence among municipal employees
LEINO-ARJAS P.	Persistent multisite pain and incident disability pensions among municipal employees
MARKKULA R.	Influence of fibromyalgia - like symptoms on early retirement and mortality: a twin cohort study



## PREVALENCE OF MULTISITE PAIN, THEIR DETERMINANTS, AND IMPACT ON HEALTH-RELATED QUALITY OF LIFE AMONG FINNISH YOUNG ADULTS

PAANANEN M., TAIMELA S., AUVINEN J., TAMMELIN T., KANTOMAA M., EBELING H., TAANILA A., ZITTING P., KARPPINEN J.

University of Oulu, Finland.

### Aims:

To investigate the role of psychosocial and lifestyle factors in predicting multiple musculoskeletal pains, and to analyse how multiple musculoskeletal pains and health-related quality of life (HRQoL) are associated among young adults.

### Methods:

The study population consisted of the Northern Finland Birth Cohort 1986. A postal questionnaire including a question about six-month period prevalence of pain in neck, shoulder, low back, and peripheral location, and also questions about psychosocial well-being and health habits was administered to a sample of 1733 cohort members at the age of 16 and 18. In addition, a subgroup of the cohort (n=874) completed 15D HRQoL questionnaire (score 0 to 1) and also answered to a question about musculoskeletal pain at the age of 19. The odds ratios (OR) and 95% confidence intervals (CI) for the possible risk factors of two-year persistence of multiple pains and for HRQoL determinants were obtained using multinomial logistic regression

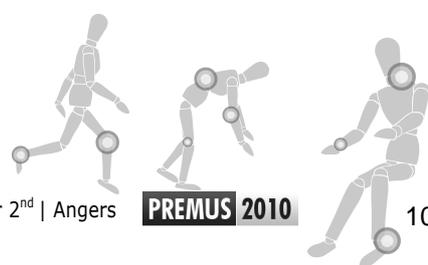
### Results:

Multiple musculoskeletal pains were common; 43% of males and 63% of females at 16, 61% of males and 81% of females at 18, and 48% of males and 74% of females at 19 reported pain in more than one site during the last six months. Moreover, multiple pains had a high persistence rate, as 75% of males and 88% of females with multiple pains at 16 reported multiple pains also at 18. In the multivariate analysis, emotional problems (OR 2.3), behavioral problems (OR 2.2), and high sitting time (OR 1.6) among males, and emotional problems (OR 3.7), high physical activity level (OR 1.6), short sleeping time (OR 1.7), and smoking (OR 1.9) among females were predictive factors for the persistence of multiple pains. Half of the males and one third of the females reported a 15D score of at least 0.98, and were selected as the reference group in the logistic regression analysis. After adjustments for psychosocial distress, parental occupation, and the young adults' own employment status, the reporting of single musculoskeletal pain (OR 3.3) and multiple pains (ORs up to 12.2) among females, and multiple pains (ORs up to 4.7) among males were associated with a 15D score of 0.94 or less.

### Conclusion:

Multiple musculoskeletal pains had a high tendency to persist among young adults, and both psychosocial factors and lifestyle factors contributed to this vulnerability. Moreover, the likelihood of reduced HRQoL appeared to increase according to the number of painful sites.

**Keywords:** Psychosocial factors, Epidemiology, Pain, chronic pain



## RECIPROCAL ASSOCIATIONS OF PSYCHOSOCIAL FACTORS AT WORK WITH MULTISITE MUSCULOSKELETAL PAIN: A TWO-YEAR FOLLOW UP STUDY AMONG KITCHEN WORKERS

HAUKKA E.<sup>1</sup>, LEINO-ARJAS P.<sup>1</sup>, OJAJÄRVI A.<sup>2</sup>, TAKALA E.P.<sup>1</sup>, VIIKARI-JUNTURA E.<sup>1</sup>, RIIHIMÄKI H.<sup>1</sup>

<sup>1</sup> Centre of Expertise for Health and Work Ability, Finnish Institute of Occupational Health, Topeliuksenkatu 41 a A, FI-00250, Helsinki, Finland - <sup>2</sup> Centre of Good Practices and Competence, Finnish Institute of Occupational Health, Topeliuksenkatu 41 a A, FI-00250, Helsinki, Finland

### Aims:

It has recently been established in the general population and among employees that most subjects with pain report it in more than one body site. Studies on the risk factors of musculoskeletal pain have traditionally examined one body site in isolation, however, and determinants of multisite musculoskeletal pain (MSP) are not well understood. Psychosocial factors are implicated in many pain disorders, but uncertainty prevails regarding the directionality of the associations.

This prospective study examined whether psychosocial factors at work predict the occurrence and developmental patterns of MSP over time. We also studied associations with the reversed time sequence, i.e. whether MSP predicts the occurrence and developmental patterns of psychosocial factors.

### Methods:

Associations between psychosocial factors - job control, skill discretion, supervisor support, co-worker relationships, hurry, and mental stress - with MSP (defined as pain at  $\geq 3$  of seven sites) were examined among 385 female kitchen workers. Data were collected by questionnaire at three-month intervals during two years. Time-lagged general estimation equations (GEE) model, trajectory analysis, and logistic regression models were used in the analyses.

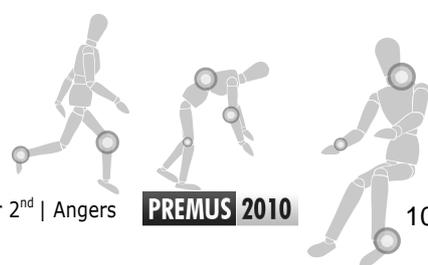
### Results:

In time-lagged analyses, all psychosocial factors but one were associated with MSP (odds ratios [OR] between 1.3 and 1.9), and vice versa, MSP predicted low job control, low supervisor support, poor co-worker relationships, and mental stress (1.3-1.9), after adjustment for covariates. By trajectory analysis, four trajectories of MSP prevalence emerged: Low, Descending, Ascending, and High. For the psychosocial factors, a two-trajectory model (Ascending or High vs. Low) yielded the best fit. In logistic regression analysis, with the Low MSP trajectory as reference, poor co-worker relationships (3.9), mental stress (3.1) and hurry (2.1) at baseline predicted belonging to the High MSP trajectory. Also, MSP at baseline predicted the trajectories (Ascending vs. Low) of low job control and mental stress (ORs 2.2 and 3.2). Adverse changes in most psychosocial factors were associated with belonging to the High (2.3-8.6) and Ascending (2.7- 5.5) MSP trajectories.

### Conclusion:

The results suggest that psychosocial factors and MSP co-vary in time. Reciprocity of the relationships complicates conclusions of their causal nature. Both measures are based on subjective perception and there may be common underlying factors, which warrant further study.

**Keywords:** Psychosocial factors, Epidemiology, Pain, chronic pain.



## MULTISITE PAIN: RISK FACTORS AND CONSEQUENCES FOR WORK ABILITY

NATVIG B.<sup>1,2</sup>, IHLEBÆK C.M.<sup>3</sup>, KAMALERI Y.<sup>4</sup>, BRUUSGAARD D.<sup>1</sup>

<sup>1</sup> Department of General Practice and Community Medicine, ASAM, University of Oslo, Norway - <sup>2</sup> National Resource Centre for Rehabilitation in Rheumatology, Diakonhjemmet Hospital, Oslo Norway - <sup>3</sup> Health UMB, Research Group for Nature, health and Quality

### Aims:

To summarize current results from the Ullensaker Study on multi-site pain and the associations with demographics, risk factors and prognosis according to disability pension.

### Methods:

A 14-year prospective postal population survey from Ullensaker, Norway.

### Results:

In the population, localized pain, in the meaning of single site pain, is relatively rare and most people have musculoskeletal pain from a number of sites. Multi-site pain is more intense and disabling compared to single-site pain. The pattern of reporting multi-site pain is relatively stable over time in adults. In multivariate analyses controlling for number of pain sites at baseline sex, age, sleep quality and educational level predicted multi-site pain after 14 years. Number of pain sites in 1990 was a strong predictor of disability pensioning in 2004 with an almost linear "dose-response" association. Most new disability pensioners over the 14 years observation period do not come from the group "with pain all over", but from the more numerous group with "pain in many sites but not all over". Other subjective health complaints than pain is also associated with reduced function and disability.

### Conclusion:

Multi-site pain is a strong, stable and almost linear risk factor for disability pensioning in a long-term prospective population study. A high risk strategy for prevention of disability will reach a small group of new disability pensioners, and we argue for a population strategy in future prevention of disability in persons with multi-site pain.

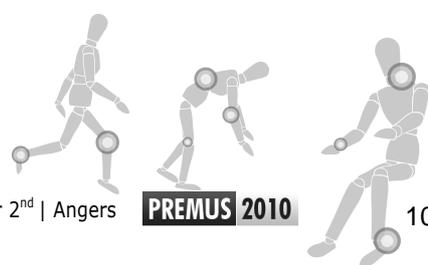
**Keywords:** Epidemiology, Disability prevention, Pain, chronic pain.

### References:

Kamaleri Y, Natvig B, Ihlebaek CM, Benth JS, Bruusgaard D. Change in the number of musculoskeletal pain sites: A 14-year prospective study. *Pain* 2009;141:25-30.

Kamaleri Y, Natvig B, Ihlebaek CM, Bruusgaard D. Localized or widespread musculoskeletal pain: Does it matter? *Pain* 2008;138:41-46.

Kamaleri Y, Natvig B, Ihlebaek CM, Bruusgaard D. Does the number of musculoskeletal pain sites predict work disability? A 14-year prospective study. *Eur J Pain* 2009;13:426-30.



## **LOW BACK PAIN, NECK PAIN AND THEIR CO-OCCURRENCE AS PREDICTORS OF SICKNESS ABSENCE AMONG MUNICIPAL EMPLOYEES**

KÄÄRIÄ S., LAAKSONEN M., LEINO-ARJAS P., SAASTAMOINEN P., LAHELMA E.

*Department of Public Health, University of Helsinki, Helsinki, Finland.*

### **Aims:**

To study the history of low back pain (LBP) (distinguishing between local pain and sciatica), neck pain (NP), and their co-occurrence, as predictors of sickness absence among employees.

### **Methods:**

The study sample (n=6911, 79% women, response rate 67%) included employees of the City of Helsinki who reached the age of 40, 45, 50, 55 or 60 years between 2000-2002. Survey data on pain, working conditions, and lifestyle were linked to register information on sickness absence until the end of 2004 (mean follow-up time 2.7 years). The duration of sickness absence was categorized as self-certified and medically certified, and the number of spells during the follow-up time was analysed using Poisson regression.

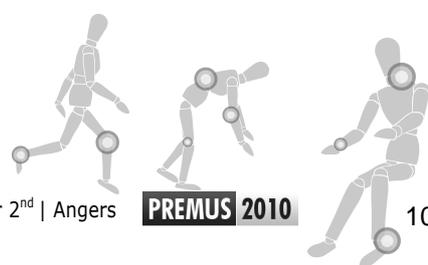
### **Results:**

All pain categories predicted self-certified sickness absence in women: rate ratios (RR) varied between 1.2 and 1.5, when adjusted for socio-demographic, work-related and lifestyle factors. In men, NP alone, and together with local LBP and sciatica, predicted self-certified sickness absence (adjusted RRs between 1.4 and 1.5). Medically certified sickness absence was predicted by sciatica (women: 1.4; 95% CI 1.1-1.6, men: 1.5, 1.0-2.1), NP (women: 1.3; 1.2-1.5, men: 1.6; 1.2-2.2), and by their combined history (women: 1.8; 1.6-2.1, men: 2.1; 1.6-2.8). Local LBP did not increase the risk of medically certified sickness absence.

### **Conclusion:**

Most categories of pain history predicted self-certified sickness absence, allowing for potential confounders. The occurrence of medically certified sickness absence was predicted by sciatica or NP, but not by local LBP. The risk was accentuated in those with both sciatica and NP.

**Keywords:** Epidemiology, Back, low back, Neck.



## PERSISTENT MULTISITE PAIN AND INCIDENT DISABILITY PENSIONS AMONG MUNICIPAL EMPLOYEES

LEINO-ARJAS P., PENTTI J., VAHTERA J.

*Finnish Institute of Occupational Health, Helsinki, Finland.*

### Aims:

We studied the significance of the number of pain sites, reported repeatedly in two surveys, as a predictor of long-term or permanent work disability among municipal employees in Finland.

### Methods:

A follow-up of part of the "Ten-Town Study". Representative samples of employees (n=2000) in the service of two neighbouring cities (Raisio and Turku) responded to repeated surveys in 1989-1993. Altogether 1398 subjects were assessed twice (90% of the eligible target population) at an interval of two years. The Standardized Nordic Questionnaire was used to assess pain in nine sites. Register-based follow-up information on disability pensions and death was linked to the data. Information on pensions included the dates and the main diagnoses of all granted permanent or fixed-term disability pensions between January 1 of the year following the last survey and December 31, 2005. Eighty-six subjects received a disability pension due to musculoskeletal disorders during the follow-up of 12.5 years on average. Cox proportional hazards regression was used in the analyses.

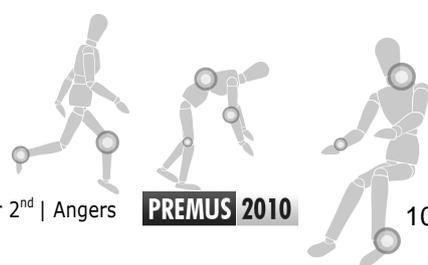
### Results:

The number of pain sites reported repeatedly was statistically significantly predictive of disability pension. Adjusted for age, gender, and socioeconomic position, having 3-4 pain sites increased the probability of disability pension with the hazard ratio (HR) of about 7, having 5-6 pain sites with a HR of 9, and having 7-9 pain sites with a HR of 16, compared with subjects with 0-1 pain site. When the number of pain sites was used as a continuous variable, the HR of disability pension was 1.36 (95% CI 1.23-1.50) for each increase of one site. Persistent multisite pain was not associated with incident disability pensions granted due to other diagnoses than those of a musculoskeletal disorder.

### Conclusion:

Persistent pain in multiple body sites strongly decreases work ability, objectively assessed as an awarded disability pension. The decrease in work ability seems to be linked with musculoskeletal disorders. Interventions to support work ability among subjects with multisite pain are needed.

**Keywords:** Epidemiology, Disability prevention, Pain, chronic pain.



## INFLUENCE OF FIBROMYALGIA - LIKE SYMPTOMS ON EARLY RETIREMENT AND MORTALITY: A TWIN COHORT STUDY

MARKKULA R.<sup>1</sup>, KALSO E.<sup>1,2</sup>, HUUNAN-SEPPÄLÄ A.<sup>3</sup>, KOSKENVUO M.<sup>4</sup>, KOSKENVUO K.<sup>4,5</sup>, LEINO-ARJAS P.<sup>6</sup>, KAPRIO J.<sup>4,7,8</sup>

<sup>1</sup> Helsinki University Central Hospital, Pain Clinic, Department of Anaesthesiology and Intensive Care Medicine, Finland - <sup>2</sup> University of Helsinki, Department of Clinical Medicine, Finland - <sup>3</sup> University of Tampere, Department of General Practice, Finland - <sup>4</sup> University of Helsinki, Department of Public Health, Finland - <sup>5</sup> The Social Insurance Institution of Finland, Helsinki, Finland - <sup>6</sup> Finnish Institute for Occupational Health, Helsinki, Finland - <sup>7</sup> University of Helsinki, Institute for Molecular Medicine, Finland - <sup>8</sup> National Institute for Health and Welfare, Department of Mental Health and Alcohol Abuse Services, Helsinki, Finland

### Aims:

To assess whether symptoms of fibromyalgia (FM) predict disability retirement or mortality.

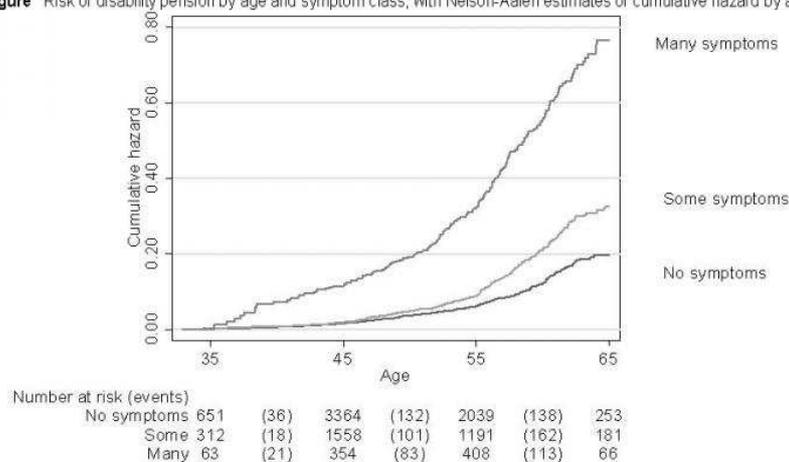
### Methods:

The study was based on the Finnish Twin Cohort and diagnosed FM patients who all had answered the same health questionnaire in 1990 -1992. A sample of 10608 working aged individuals of the cohort was classified in homogenous groups based on their symptom profile with latent class analysis, using a battery of questions addressing FM-associated symptoms validated between the FM-patients and the twins. This resulted in three classes: no or few symptoms (LC1), some symptoms (LC2) and a high load of FM-symptoms (LC3). In a 14-year follow-up 1990 - 2004, information on disability retirement was obtained by record linkage with the Finnish official pension registers. Further linkage with data at the Population Register Centre 1990 – 2009 yielded information on the vital status of the cohort subjects. Subjects with malignancies or inflammatory rheumatic diseases were excluded. The cumulative incidences and the hazard ratios (HR) for early retirement and mortality across the three latent symptom classes were analyzed.

### Results:

The cumulative incidence of early disability retirement was 9.5% among all the 8448 individuals left after exclusions. In LC3 it was 26%. The adjusted HRs for early retirement for all causes were 1.0 (reference class) in LC1, 1.5 (CI 1.2 -1.7) in LC2 and 2.9 (CI 2.4-3.6) in LC3. In 173675 person years, the high symptom class (LC3) had a 30% increased overall risk for death, which decreased strongly when adjusted for smoking, drinking to intoxication, depression and BMI.

Figure Risk of disability pension by age and symptom class, with Nelson-Aalen estimates of cumulative hazard by age.



### Conclusion:

Fibromyalgia-like symptoms have a strong connection with early disability retirement. Depression and life style problems associated with this symptom load need early management to avoid increased risk of mortality. The possibility to avoid disability retirement by management of symptoms needs further clarification.

**Keywords:** Pain, chronic pain, Other.

### References:

- White KP, Speechley M, Harth M, Ostbye T. Comparing self-reported function and work disability in 100 community cases of fibromyalgia syndrome versus controls in london, ontario: The london fibromyalgia epidemiology study. *Arthritis Rheum.* 1999;42(1):76-83.
- Markkula R, Jarvinen P, Leino-Arjas P, Koskenvuo M, Kalso E, Kaprio J. Clustering of symptoms associated with fibromyalgia in a finnish twin cohort. *Eur J Pain.* 2009;13(7):744-750.
- van Amelsvoort LG, Kant IJ, Beurskens AJ, Schroer CA, Swaen GM. Fatigue as a predictor of work disability. *Occup Environ Med.* 2002;59(10):712-713.



## **MUSCULOSKELETAL DISORDERS AND ERGONOMIC CHALLENGES IN MODERN DAIRY PRODUCTION: EUROPEAN AND US PERSPECTIVES**

### ***Symposium Description***

#### **RATIONALE**

The new economy has led to transformations of modern milking practices on dairy farms in the EU and US. Modern technologies and improved dairy husbandry practices have led to task specialization and increased milk yields. The profile of EU dairy operations continues to be one of smaller herds which is mainly influenced by a milk quota system. Modern dairy production in the US is quickly moving to large-herd operations because of associated economies of scale and a host of other economic and social conditions. Over the past two decades the US dairy industry has adopted an industrialized mass production model with the goal of increased milk production at lower costs. Milking practices in EU and US place unique demands on dairy workers. Modern milking involves high repetitions, reduced rest times, awkward postures, high muscle loads and close-proximity with the dairy cow. These risk factors increase the risk for the development musculoskeletal disorders and acute traumatic injury.

#### **GOAL**

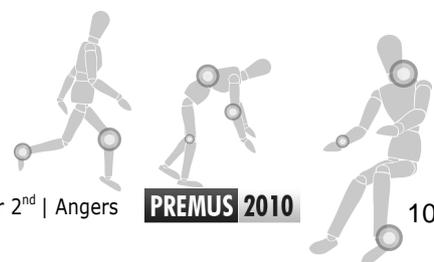
Presenters for this symposium will include both US and Swedish researchers who have conducted numerous ergonomic research projects involving modern dairy operations. This symposium will provide an overview of modern milking practices in the EU and US, and present current ergonomic research that addresses worker health and safety in modern EU and US dairy operations.

### ***Symposium Author***

Dr. David DOUPHRATE

### ***Authors linked to the Name of their abstract symposium***

DOUPHRATE D.I.,	European and US dairy production: challenges of work-related musculoskeletal disorder prevention
KOLSTRUP C.	Musculoskeletal symptoms among US and Swedish dairy workers
PINSKE S.	Quantifying physical work load in different milking practices
STAL M.	Median nerve entrapment at the elbow level – pronator syndrome - a follow up study after surgical release
ROSECRANCE J.C.	Carpal tunnel syndrome among US dairy parlor workers



## **EUROPEAN AND US DAIRY PRODUCTION: CHALLENGES OF WORK-RELATED MUSCULOSKELETAL DISORDER PREVENTION**

DOUPHRADE D.I.<sup>1</sup>, KOLSTRUP C.L.<sup>2</sup>, ROSECRANCE J.C.<sup>1</sup>, REYNOLDS S.J.<sup>1</sup>, LUNDQVIST P.<sup>2</sup>, PINSKE S.<sup>2</sup>, STÅL M.<sup>2</sup>

<sup>1</sup> Colorado State University, Fort Collins, Colorado, USA – <sup>2</sup> Swedish University of Agricultural Sciences, Alnarp, Sweden

### **Aims:**

The new economy has led to transformations of modern milking practices on EU and US dairy farms. The EU and US rank as the top two dairy producers in the world. Despite their high volumes of milk production, milking practices differ between these two global milk producers. The aims of the presentation include: 1) to understand differences in EU and US dairy production, and 2) to understand ergonomic challenges in EU and US milking systems.

### **Methods:**

The profile of EU dairy operations continues to be one of smaller herd operations which are influenced by a quota system. Smaller EU farms continue to utilize the “tethering” milking system, where cows are tied up and the milker carries milking equipment to each cow. The milker must kneel or squat to perform milking tasks on each cow.

Dairy production in the US is moving to large-herd operations because of economies of scale. Over the past two decades the US dairy industry has adopted an industrialized production model with the goal of increased milk production at lower costs. In 2008, 58.5% of US milk production came from operations of 500 head or more, with 30.5% coming from operations of 2,000 head or more. In the US, the parlor milking system is more common. Parlor systems involve cows moving into stationary stalls where they are milked simultaneously. Workers are located in a pit adjacent and below the stalls. Parlor systems accommodate large numbers of cows and are used exclusively in large-herd operations. Three parlor configurations are commonly used: parallel, herringbone and rotary. These configurations present different workstation designs and may create different worker demands and physical risk factors.

### **Results:**

Modern milking involves high repetitions, reduced rest times, awkward postures, high muscle loads and close-proximity with the dairy cow. These risk factors increase the risk of musculoskeletal disorders and acute traumatic injury. Milking in tethering or parlor systems places unique physical demands on parlor workers. A tethering system may increase exposure to physical risk factors involving the low back and lower extremities, and a parlor system may increase exposure to the upper back and upper extremity.

### **Conclusion:**

More focused ergonomic research should investigate milking practices and parlor designs as they relate to worker safety and health. Additional dairy-related injury research is vital given the international trend toward large industrial milking operations. International research collaboration is key to develop safer milking systems and practices.

**Keywords:** Agriculture, Work organization, Vulnerable workers.

### **References:**

van Arendonk J, Liinamo A. Dairy cattle production in Europe. *Theriogenology*. 2003;59:563-569.

National Agriculture Statistics Service, US Department of Agriculture. Milk Cows and Production National Statistics. Retrieved from [www.nass.usda.gov](http://www.nass.usda.gov) on January 5, 2010.

Douphrate D, Nonnenmann M, and Rosecrance J. Ergonomics in industrialized dairy operations. *J of Agromedicine*. 2009;14:406-412.



## MUSCULOSKELETAL SYMPTOMS AMONG US AND SWEDISH DAIRY WORKERS

KOLSTRUP C.L.<sup>1</sup>, DOUPHRATE D.I.<sup>2</sup>, PINZKE S.<sup>1</sup>, STÅL M.<sup>1</sup>, LUNDQVIST P.<sup>1</sup>, ROSECRANCE J.C.<sup>2</sup>, REYNOLDS S.J.<sup>2</sup>

<sup>1</sup> Swedish University of Agricultural Sciences, Alnarp, Sweden – <sup>2</sup> Colorado State University, Fort Collins, Colorado, USA

### Aims:

In a global perspective, the trend as regards farm structure is evident - operations become fewer in number but larger in herd sizes. Though, the structure of modern dairy farming differs between countries e.g. from huge commercial operations with thousands of cows in the United States (US) to family farms with smaller milking herds in Sweden. Large dairy operations in Sweden and US have become labour intensive industries with a high degree of task specialization. This specialization involves high physical work load, repetition, tasks often conducted in awkward postures with reduced resting time - all these, which are known risk factors for the development of musculoskeletal disorders (MSD).

### Methods:

The standardized Nordic Questionnaire was used in Swedish and US studies for assessment of perceived symptoms of MSD in different body parts [1]. The studied subjects comprised approximately 5,300 male and female workers at Swedish dairy farms with <100 cows per herd. The ongoing US study comprised 280 Hispanic/Latino workers at operations with an average herd size of 2,661.

### Results:

In general, the results from the Swedish studies showed that approximately 80% of male and 90% of female workers reported some kind of MSD. The problems were primarily located to the shoulders (54%), lower back (57%) knees (41%), neck (36%) and hands/wrists (32%). Symptoms of MSD were more frequently reported among females, especially in the shoulders (70%) and hands/wrist (53%) compared to their male colleagues (49% and 30%, respectively). Repetitive and monotonous work, physical work load, extreme work postures, poor illumination in the milking parlor, being female or short of stature was identified as risk factors for MSD [2]. In the US studies approximately 88% of the workers reported some kind of MSD. The most frequently reported symptoms of MSD, among predominantly Hispanic/Latino workers (98%), were in the feet (49%), shoulders (39%), hands/wrist (32%) and lower back (29%). Additional to the Swedish studies, females reported higher frequencies of MSD regarding all body parts than their male colleagues. In general, the frequency of MSD was lower among US workers. Working in hot, cold, humid and wet conditions, and continuing to work when injured or hurt were reported as routine occurrences [3].

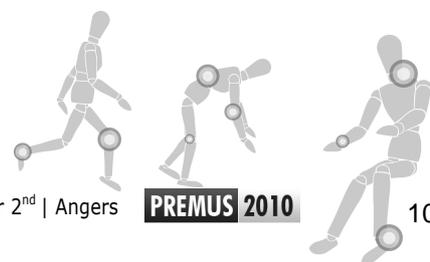
### Conclusion:

Symptoms of MSD were frequently reported among workers in US and Sweden, especially among females. Many body parts were involved in the MSD complaints and high levels of complaints existed. Dairy parlor work is physically demanding and may constitute a risk for the development of MSD.

**Keywords:** Agriculture, Social aspects of MSD, Gender differences.

### References:

- [1] Kourinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G. & Jorgensen K. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Erg.* 1987;18(3): 233-237
- [2] Kolstrup C. Work environment and health among Swedish livestock workers (Dissertation). *Acta Universitatis agriculturae Sueciae.* 2008:43; <http://diss-epsilon.slu.se/archive/00001758>.
- [3] Douphrate D, Rosecrance J and Reynolds S. Injury risk analysis in large-herd dairy parlors. 2010. Unpublished data.



## QUANTIFYING PHYSICAL WORK LOAD IN DIFFERENT MILKING PRACTICES

PINZKE S., KOLSTRUP C.L.

Work Science, Swedish University of Agricultural Sciences, Alnarp, Sweden

### Aims:

The number of milk producers in Sweden as well as in most of the western world has continuously decreased. At the same time the livestock herds have become larger. This structural development affects the work situation and the individual's exposure to risk factors. Almost all dairy-farm workers report musculoskeletal symptoms (Pinzke, 2003). Milk producers today invest in large loose-housing systems with the goal to maximise profit which means that the number of cows per unit area is an important factor in the investment estimate. In these systems the milking is performed either in parlours or in rotaries where the cows are milked from behind or from the side. To give advices from an ergonomic point of view about the best technical solutions and work technique and to avoid musculoskeletal disorders - it is important to estimate the level of work load in these systems. The aim is to quantify the work load on the farmers body joints in systems with milking from behind compared with milking from the side.

### Methods:

Twelve farm workers representing different body heights will participate in the study. Four designs will be studied on four large dairy farms in Sweden; parlour (herringbone), rotary (herringbone), parlour (side-by-side), rotary (side-by-side). Measures of the designs and the weight of the milking equipment will be assessed at the farms. The workers will be video taped to register work postures and movement during the milking operations: Cleaning (the cow's udder), Pre-milking and Attaching (the milking unit to the udder). Work height and distance to the cow will be measured for the operations and in the different systems. The human modelling software JACK© (Siemens) and 3D-Static-Strength-Prediction-Program (University of Michigan) will be used to quantify the load at the upper extremities. The farm worker's postures and the measured distances will be input to the JACK-calculations.

### Results:

The study is on-going and preliminary results will be presented in August 2010.

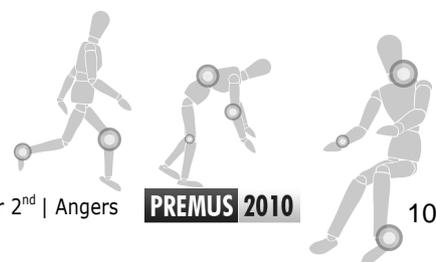
### Conclusion:

The studied milking operations have in earlier studies showed high muscle loads in combination with extreme positions and movements of the hand and forearm which might contribute to the development of injuries among milkers (Pinzke et al., 2001). Thus, there is a need of developing technical devices and working techniques to facilitate the milking operation.

**Keywords:** Biomechanics, Postures, physical exposure, Agriculture.

### References:

- Pinzke S, Stål M, Hansson G-Å. Physical workload on upper extremities in various operations during machine milking. *Ann Agric Environ Med.* 2001;8:63–70  
Pinzke S. Changes in working conditions and health among dairy farmers in southern Sweden. A 14-year follow-up. *Ann of Agric Environ Med.* 2003;10:185–195



## **MEDIAN NERVE ENTRAPMENT AT THE ELBOW LEVEL – PRONATOR SYNDROME - A FOLLOW UP STUDY AFTER SURGICAL RELEASE**

STÅL M., HAGERT C.G., ENGLUND J.E.

*Swedish University of Agricultural Sciences, Dept of Work Science, Business Economics and Environmental Psychology, Alnarp, Sweden*

### **Aims:**

A follow-up study (8.5 and 10 years respectively) evaluating the outcome of surgical release of the median nerve at the elbow level, as well as the outcome of those who did not undergo surgery.

### **Methods:**

Questionnaires:

The Nordic questionnaire (Kuorinka et al. 1987). In addition, a special questionnaire was used to register the occurrence of numbness, tingling sensations and the weakness. Physical examination: Mobility, the range of movement, atrophy, tenderness test of individual muscle strength. The testing focused on the median nerve innervated muscles flexor pollicis longus (FPL), flexor digitorum profundus (FDP II), flexor carpi radialis (FCR) as these muscles had been found weakened prior to the surgery.

### **Results:**

Surgical group (n=8)

Tenderness, none had a focal tenderness on palpation over the median nerve in the cubital fossa.

Muscle strength, the manual testing revealed no selection weakness in any of the muscles examined. The test was focused on median nerve innervated muscles FCR, FPL and FDP II.

Non-surgical group (n=14). Tenderness, twelve of the 14 patients had still tenderness. Muscle strength, ten of the 14 patients showed the same weakness at the follow-up.

### **Conclusion:**

Based on the results of the follow-up study the conclusion was;

Selective weakness of the median innervated muscles FCR, FPL and FDP II along with the distinct focal tenderness over the median nerve constitute fully reliable diagnostic criteria of pronator syndrome. While this was a small study, it appears that surgical release of the median nerve at the elbow provide immediate as well as long-term return to normal strength of FCR, FPL and FDP II.

**Keywords:** Agriculture, Upper limb, Pain, chronic pain.

### **References:**

- Seffarth H. Primary myositis in the pronator teres as cause of lesion of the n. medianus (pronator syndrome). *Acta Psychiatr. Neurol. scand* 1951, 74: 251-254. 1951; 74: 251-254
- Kuorinka I, Jonsson B, Kilbom Å., Vinterberg H, Biering-Sørensen F, Andersson G & Jørgensen K. Standardized Nordic questionnaire for the analysis of musculoskeletal symptoms. *Appl Ergon* 1987; 8: 233-237.
- Stål M, Hagert C-G and Moritz. U. Upper extremity nerve involvement in Swedish female machine milkers. *American J. Ind. Med.* 1998; 33(6) : 551-559.



## **CARPAL TUNNEL SYNDROME AMONG US DAIRY PARLOR WORKERS**

ROSECRANCE J.C., DOUPHRATE D.I., PATIL A.

*High Plains Intermountain Center for Agricultural Health and Safety, Colorado State University, Fort Collins, Colorado, USA.*

### **Aims:**

Smaller profit margins and the need to operate on economies of scale has led to an industrialization of dairy operations in the United States (Reinemann, 2001). It is not unusual for dairy operations to milk 2,000 to 10,000 head several times per day in large-herd dairy parlors. Industrialized milking parlors involve work tasks characterized as rapid, highly repetitive, forceful, and awkward postures of the upper extremity. The purpose of this study was to determine the prevalence of carpal tunnel syndrome among dairy parlor workers as compared to a control group from other areas of the dairy.

### **Methods:**

Thirty dairy parlor workers and 30 non-parlor workers at identical dairies were recruited to participate in structured interviews regarding hand symptoms, past medical conditions, current and previous work activities, and personal characteristics. Participants also received electrophysiologic studies of the median and ulnar nerves across the carpal canal. The CTS case definition was based on characteristic CTS symptoms and an abnormal median distal latency as compared to the ulnar distal latency. All job tasks were assessed with the Strain Index (Moore & Garg, 1995) and Hand Activity Level (Latko et al., 1997) to determine the risk for distal upper extremity disorders.

### **Results:**

All job tasks in the dairy parlor were rated at higher risk for distal upper extremity disorders than non-parlor dairy tasks on the Strain Index as well as the Hand Activity Level. The prevalence of CTS was higher among parlor workers than non-parlor works.

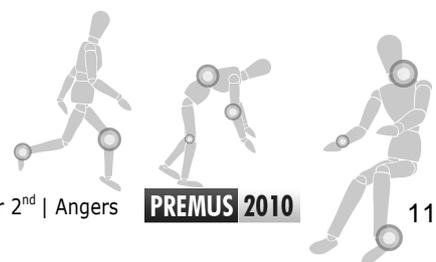
### **Conclusion:**

Dairy workers performing highly repetitive tasks such as those found in large-herd dairy parlors appear to be at greater risk for upper extremity disorders than controls working in other areas of the dairy. Work tasks in dairy parlors, especially in large-herd industrialized operations, need additional study to identify engineering as well as administrative controls to reduce the risk of workers developing upper extremity disorders. Interventions focused on worker safety must also be integrated into methods to improve herd health while maintaining production efficiency.

**Keywords:** Agriculture, Vulnerable workers, Carpal tunnel syndrome.

### **References:**

- Latko WA, Armstrong TJ, Foulke JA, Herrin GD, Rabourn RA, Ulin SS. 1997. Development and evaluation of an observational method for assessing repetition in hand tasks. *Am Ind Hyg Assoc J.* 58(4):278-85.
- Moore JS, Garg A. 1995. The strain index: a proposed method to analyze jobs for risk of distal upper extremity disorders. *Am Ind Hyg Assoc J.* 56:55, 443-458.
- Reinemann D. 2001. Evolution of automated milking in the USA. First North American Conference on Robotic Milking Toronto, Ontario



## NIOSH UPPER EXTREMITY MUSCULOSKELETAL DISORDER CONSORTIUM STUDIES

### Symposium Description

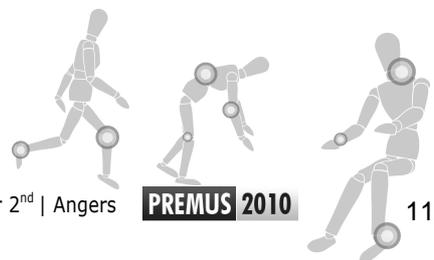
The NIOSH sponsored Work-related Musculoskeletal Disorder Consortium (MSDC) studies seek to provide a quantitative understanding of the exposure-response relationships between ergonomic risk factors at the workplace, such as hand activity level and forceful exertion, and the risk for developing hand, wrist, elbow, and shoulder musculoskeletal disorders (MSDs) across various occupations and industries. Another goal is to evaluate and improve existing exposure and health assessment tools and develop new tools. Prior to this collaborative effort, it was difficult to pool data across studies to quantify exposure-response relationships because exposure metrics and health outcome case definitions differed widely. Although each MSDC study is independent, data collection methods provide some common elements for exposure assessment and health outcomes. Detailed quantitative exposure data were collected by all of the research groups at the individual worker level, and physical examinations, questionnaires, and nerve conduction studies were conducted at baseline and periodically during follow-up periods ranging from 2 to 7 years. Data were also collected to allow analysis of the effects of individual and psychosocial/work organizational factors. This symposium will present research findings to date from the individual studies and discuss the plans the MSDC has to pool data across studies for an expanded sample size (N=3573) and a broad distribution of exposures across a wide range of jobs and industries.

### Symposium Author

Dr. Susan BURT

### Authors linked to the symposium

Authors linked to the symposium	Name of their abstract
BURT S.	Carpal tunnel syndrome at 3 workplaces – job and individual factors
SILVERSTEIN B.	Prospective study of rotator cuff, epicondylitis and carpal tunnel syndrome in 12 US workplaces
HARRIS C.	Workplace and individual factors and wrist tendonitis: the San Francisco Study
HEGMANN K.	Risk factors for lateral epicondylalgia from a 7-year prospective cohort study
GARG A.	Individual, psychosocial and job physical risk factors for CTS: results from a 7-year prospective cohort study
EVANOFF B.	Risk factors for incident carpal tunnel syndrome: results of a prospective cohort study of newly-hired workers



## CARPAL TUNNEL SYNDROME AT 3 WORKPLACES – JOB AND INDIVIDUAL FACTORS

BURT S.<sup>1</sup>, CROMBIE K.<sup>1</sup>, RAMSEY J.<sup>1</sup>, WURZELBACHER S.<sup>1</sup>, JIN Y.<sup>1</sup>, DEDDENS J.<sup>2</sup>

<sup>1</sup> National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA - <sup>2</sup> University of Cincinnati, Cincinnati, Ohio, USA, National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA

### Aims:

The purpose of this study is to evaluate risk factors for carpal tunnel syndrome (CTS), including physical job stressors such as frequency and intensity of exertion and awkward posture as well as individual and organizational factors. Another goal is to compare detailed quantitative exposure assessment measures to those requiring only ratings.

### Methods:

Each study participant's job tasks were evaluated for hand activity level (HAL), forceful exertion and other physical stressors and videotaped for further analysis, including frequency and duration of exertion and postural deviation. Physical examinations including electrodiagnostic testing of median and ulnar nerve conduction latency and questionnaires were administered to all participants. The criteria for CTS case required nerve conduction results consistent with median mononeuropathy and hand diagrams showing burning, numbness, tingling or pain in the median nerve distribution. Job and individual factors identified in earlier studies were tested in univariate analysis for statistically significant associations with CTS. Statistically significant variables were then analyzed using multiple logistic regression (MLR) in separate models representing quantitative and ratings-based exposure measures. Confounding and 2-way interactions were evaluated.

### Results:

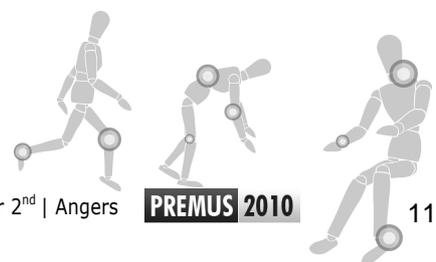
57/477 (11.9%) of the study population, which included hospital and laboratory workers and employees from a school bus manufacturing plant and an engine assembly plant, were dominant hand CTS cases. In the quantitative exposure MLR model, peak force  $\geq 70\%$  maximum voluntary contraction (MVC) vs.  $< 20\%$  MVC resulted in an OR of 2.74 (1.32-5.68) for CTS.

Among those with a BMI  $\geq 30$ , 10 -  $< 15$  exertions per minute resulted in an OR for CTS of 2.92 (0.90-9.46), and the OR for  $\geq 15$  exertions per minute was 3.35 (1.14-9.87). In the  $\geq 15$  exertions per minute category, BMI  $\geq 30$  had an OR of 2.26 (1.01-5.10) for CTS. In the ratings-based MLR model, peak worker ratings of perceived exertion (RPE) increased the odds for CTS by 1.13 (1.00-1.27) for each unit increase on the 10-point scale. The odds for CTS increased by 1.38 (1.03-1.85) for each unit increase on the HAL 10-point scale among men, but not women; the odds for CTS increased by 1.06 (1.02-1.11) for each unit increase in BMI. Posture and age were not statistically significant in either model.

### Conclusion:

Frequency of exertion and peak force were each significantly associated with CTS when detailed quantitative exposure measures were used; BMI modified the effect of frequency of exertion. When ratings were substituted for quantitative measures, worker RPE and HAL appeared to be adequate surrogates for quantitative exposure measurements in this study.

**Keywords:** Postures, physical exposure, Epidemiology, Carpal tunnel syndrome



## PROSPECTIVE STUDY OF ROTATOR CUFF, EPICONDYLITIS AND CARPAL TUNNEL SYNDROME IN 12 US WORKPLACES

SILVERSTEIN B., FAN Z.J., BAO S.S., SMITH C.K., BONAUTO D.K., HOWARD N., VIKARI-JUNTURA E.

*SHARP Washington State Dept Labor & Industries USA, a Finnish Institute of Occupational Health, Finland*

### Aims:

To characterize the relationship between personal, physical load, and work psychosocial factors and development of upper limb disorders in an industrial and health care working population

### Methods:

Out of 733 participants at baseline, 445 initial non-cases were followed up to 3 years. Participants had detailed musculoskeletal health assessment including wrist NCVs and individual detailed exposure assessment at baseline 1. Annual health assessments and exposure assessments were conducted. Survival analysis was used to assess the relationship between personal and work exposures with clinical cases. Cut points for exposure variables were based on previous studies and distributions in our study population (trichotomous or dichotomous). SAS PHREG was used to handle the counting process style of input by modeling the marginal distribution of time until event. Age, gender and BMI were included in all models

### Results:

Age, gender and BMI were included in all models with only BMI statistically significant. Demand, control and social support were not significant predictors. While frequency was important for RCS, force was more important for epicondylitis and carpal tunnel syndrome. Significant exposure-response relationships were seen for frequency of shoulder movement for RCS, forearm supination with lifting >4kg for epicondylitis and peak hand force for CTS.

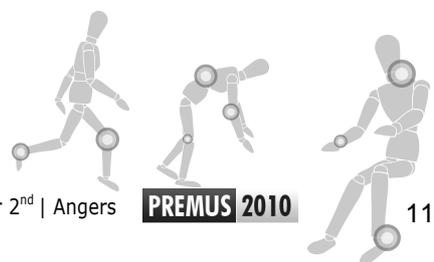
### Conclusion:

While frequency was important for RCS, force was more important for epicondylitis and carpal tunnel syndrome. Loss to follow-up was primarily due to the economic recession, with no difference between prevalent cases and non-cases. Detailed posture analysis may not be necessary to identify high-risk jobs if either percent time or frequency of forceful exertions are considered.

**Keywords:** Exposure measurement methods, Epidemiology, Upper limb

### Reference:

Silverstein et al. Gender adjustment or stratification in discerning upper extremity musculoskeletal disorder risk. *SJWEH* 2009; 35(2):113-26.



## WORKPLACE AND INDIVIDUAL FACTORS AND WRIST TENDONITIS: THE SAN FRANCISCO STUDY

HARRIS C., EISEN E., GOLDBERG R., KRAUSE N., REMPEL D.

*Division of Occupational and Environmental Medicine, University of California, San Francisco, USA*

### Aims:

Wrist tendonitis is a common work-related upper extremity disorder. Workplace cross-sectional (Franzblau 2005) and prospective studies (Leclerc 2001, Thomsen 2007) have linked hand/wrist tendonitis to forceful or repetitive hand exertions, but the associations are not consistent across studies. We report preliminary findings on a prospective study of wrist tendonitis among blue-collar workers.

### Methods:

Workers (N=359) at four industries were followed up for up to 28 months with questionnaires and physical examinations every 4 months to identify incident cases of right wrist tendonitis. Workers were eligible to participate if they performed primarily hand intensive manual (not office) work and were not assigned to more than four tasks. Exposure assessment was based on job evaluations by experienced ergonomists and video analysis of tasks. Detailed video analysis determined percent time the right hand applied a high force (> 1 kg-force) pinch or power grip for each task and time weighted average exposures were calculated for each subject. Survival analysis using the Cox Proportional Hazards Model was used to assess the relationship between individual and workplace factors and wrist tendonitis. Variables with  $p < 0.2$  in the univariate analyses were included in a large model then variables were eliminated using a backward stepwise approach.

### Results:

During the follow-up period there were 30 incident cases of right wrist tendonitis. Job satisfaction, smoking status, annual income, education level, and general health were not significant predictors in the univariate analysis and were therefore not included in the model. Age, gender, BMI and ethnicity were included in all models. Six variables remained in the final model and the significant variables were percent time spent in high force pinch (HR = 4.56; CI: 2.02-10.23;  $p < 0.0001$ ), shift status (HR = 13.48; CI: 1.79-101.63;  $p = 0.012$ ), and female gender (HR = 2.52; CI: 1.11-5.73;  $p = 0.027$ ).

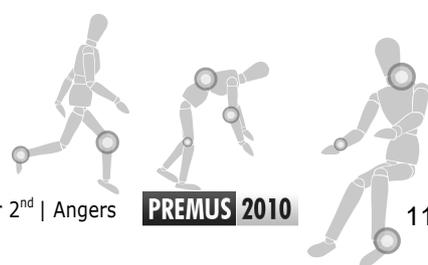
### Conclusion:

In this prospective study, the workplace factors predicting incident cases of wrist tendonitis were the shift and the percent time spent performing a high force pinch calculated as a TWA. Time spent in power grip was not a significant workplace predictor. Individual factors of gender was a significant predictor, but job satisfaction, general health, and BMI were not. Future analysis of this data set will evaluate the role of repetition, contact stress and other factors.

**Keywords:** Postures, physical exposure, Epidemiology, Upper limb.

### References:

- Franzblau A, Armstrong TJ, Werner RA, Ulin SS. A cross-sectional assessment of the ACGIH TLV for hand activity level. *J Occup Rehabil* 2005; 15:57-67.
- Leclerc, A., MF Landre, JF Chastang., I Niedhammer. and Y Roquelaure (2001). Upper-limb disorders in repetitive work. *Scand J Work Environ Health* 2001; 27:268-78.
- Thomsen, J. F., S. Mikkelsen, et al. Risk factors for hand-wrist disorders in repetitive work. *Occup Environ Med* 2007; 64:527-533.



## RISK FACTORS FOR LATERAL EPICONDYLALGIA FROM A 7-YEAR PROSPECTIVE COHORT STUDY

HEGMANN K.T., GARG A., THIESE M., KAPELUSCH J., WOOD E., DECKOW-SCHAEFER G., BLOSWICK D., MERRYWEATHER A., MOORE J.S.

RMCOEH, University of Utah, SLC, USA

### Aims:

To quantify risks for lateral epicondylalgia in a cohort study.

### Methods:

A total of 791 workers were enrolled in 2 diverse US states (UT, WI). Workers were followed for up to 7 years. Baseline procedures include questionnaires, structured interviews, 2 standardized physical examinations, subjective and objective job exposure methods. Job evaluation methods include: ratings of perceived exertion, cycle time, force matching, Strain Index, and TLV for Hand Activity Level. The cohort was followed on a monthly basis with a monthly structured interview and physical examinations to ascertain changes in case status, as well as surveillance for job changes. A case definition of lateral epicondylalgia is all of: 1) pain in the lateral elbow plus 2) tenderness in at least 1 of 6 lateral elbow tender points, and 3) stated cause from work or "unsure." A patient who underwent surgery for lateral epicondylar release was also considered a case provided that it was considered work-related or of unsure cause. Risks were calculated by hand using Cox proportional hazards modeling.

### Results:

A total of 240 subjects met the case definition of right lateral epicondylalgia or had lateral elbow surgery at baseline and were excluded from analyses. Among 551 subjects with complete baseline data and at least one month of follow-up data who were eligible to become an incident case, 62 of 551 (11.3%) developed an incident case of right lateral epicondylalgia. Most eligible workers were female (66.2%) as were cases (74.2%) (NS risk for gender). Age was strongly associated with increased risk with increased age (HR, overall trend  $p=0.0011$ ). Risk was also elevated in obese compared with normal weight subjects (HR 4.13, 95% CI 1.71-9.97,  $p=0.01$ ). Risk was elevated with baseball (HR=6.9). Feeling depressed was associated with increased risk ("Often" HR=5.2; "Seldom" HR=3.1). Job satisfaction was protective ("Very Satisfied" HR=0.13; "Satisfied" HR=0.31; "Neither" HR=0.42). Additional risks included increased heart rate (HR=1.03 per beat), wrist width (HR=0.79). Job physical factors will be reported, with preliminary analyses suggesting job physical factors contributing risk.

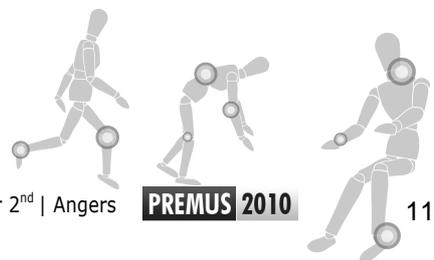
### Conclusion:

There are many apparent risk factors for lateral epicondylalgia. These include a mix of personal, psychosocial and job physical factors. These risks are similar, though not identical to those of carpal tunnel syndrome, and suggest control and prevention is likely to be complex.

**Keywords:** Epidemiology, Upper limb, Specific health outcomes.

### Reference:

Musculoskeletal Disorders and Workplace Factors. Bernard, B (Ed). US Dept. HHS. NIOSH 1997.



## INDIVIDUAL, PSYCHOSOCIAL AND JOB PHYSICAL RISK FACTORS FOR CTS: RESULTS FROM A 7-YEAR PROSPECTIVE COHORT STUDY

GARG A., HEGMANN K.T., WERTSCH J., KAPELLUSCH J., MERRYWEATHER A., SCHAEFFER G., THIESE M., BLOSWICK D.

University of Wisconsin-Milwaukee, USA

### Aims:

A multi-center prospective cohort study was conducted to (1) determine incidence rate over a 6 year period for carpal tunnel syndrome for 3 levels of job physical exposures (low, medium, high) and (ii) quantify risk for CTS using individual risk factors (e.g., force, posture, repetition, etc.), the ACGIH TLV for HAL and the Strain Index

### Methods:

A cohort of 610 workers from 15 different industries in two diverse states participated in the study to help ensure generalizability of the study results. To maximize objectivity, job physical exposures were primarily measured to quantify exposures. To maximize clinical and epidemiological validity, all participants had health outcomes assessed by certified therapists and qualified physicians. These included: baseline questionnaires, structured interviews and standardized physical examinations. Changes in job physical exposures were monitored quarterly. Specific disorders and symptoms were assessed monthly using a structured interviews and physical examinations on those with symptoms. A Board Certified physician in physical medicine and rehabilitation provided electrodiagnostic testing (at baseline, and during follow-up). Job physical exposure and health outcomes assessment teams were blinded to each other throughout the field observation phase. Cox proportional hazard modeling was used to calculate risks.

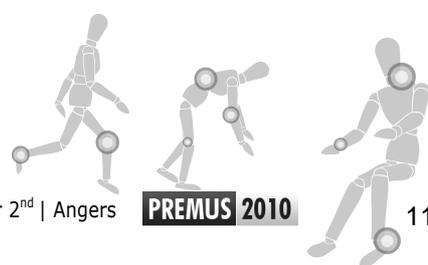
### Results:

Follow up data were available were for 594 workers. At the person level, there were 41 incident cases of CTS (34 for right hand and 35 for left hand). BMI (HR =4.3, 95%CI = 1.54-12.51 for morbidly obese), gender (HR = 4.9, 1.66-14.90 for females), high cholesterol (HR = 2.5, 1.19-5.24) and previous history of fractures (HR = 2.44, 1.25-4.77) were associated with incident cases of CTS. Age, while not statistically significant, showed trend with those above 50 years of age having the highest HRs. There was no clear evidence of associations between all other hobbies, physical activities, psychosocial factors, past medical history and incident cases of CTS. Preliminary analyses showed a relationship between job physical factors (being currently analyzed) and incident cases of CTS.

### Conclusion:

Prevention and control of CTS would require addressing both individual and job physical factors which are associated with increased risk of CTS. Psychosocial factors, hobbies and physical activities outside work appear to be least important

**Keywords:** Biomechanics, Epidemiology, Carpal tunnel syndrome



## RISK FACTORS FOR INCIDENT CARPAL TUNNEL SYNDROME: RESULTS OF A PROSPECTIVE COHORT STUDY OF NEWLY-HIRED WORKERS

EVANOFF B., DALE A.M., DEYCH E., FRANZBLAU A.

Washington University School of Medicine, St. Louis, MISSOURI, USA

### Aims:

To identify risk factors for incident carpal tunnel syndrome.

### Methods:

We enrolled 1107 newly employed workers from a variety of industries in three year prospective study. At baseline each worker received a physical examination and completed a questionnaire that included hand symptoms, job title, self-reported work exposures, personal health, and psychosocial factors. Questionnaires were repeated at 6, 18, and 36 months. Cases of CTS were defined as a Katz hand diagram rated "probable" or "classic" for CTS. Subjects who met the case definition at baseline were excluded from analysis.

Work-related exposures were estimated by self-report and by job title. Workers reported average daily time for 7 physical exposures using a modified Nordstrom questionnaire:

hand/wrist bending, forearm rotation, pinch grip, use of hand-held vibrating power tools, finger/thumb pushing/pressing, forceful grip, and lifting >1 kg. Based on job titles, 13 exposure variables were extracted from O\*NET, a publicly available database developed by the U.S. Department of Labor, using variables related to hand strength, dexterity and speed and repetitive movements.

Logistic regression models used the maximum reported exposure during the observation period, or the most recent exposure preceding the onset of symptoms.

### Results:

Out of 1107 workers enrolled at baseline, follow-up data at one or more time points were available for 985 (89%), with 80% follow-up at 36 months. 110 workers had an incident case of CTS during follow-up. In logistic regression models adjusted for age, gender, and body mass index (BMI), multiple self-reported physical exposures were statistically significantly associated with incident CTS, including forceful gripping, wrist bending, lifting > 1kg, forearm rotation, and use of vibrating hand tools (Odds ratios ranged from 1.73 to 2.46). In models using job-title based estimates of exposure, significant exposure variables included job requirements for static strength, speed of limb movement, and exposure to vibration. Factor analysis combined the 13 O\*NET variables into three factors, corresponding to force, repetition, and vibration. When these three factors were entered together into logistic regression models that also included age, gender, and BMI, the force and repetition variables were significantly associated with incident CTS.

### Conclusion:

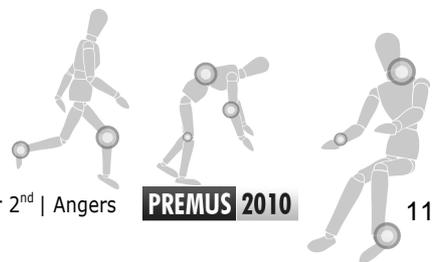
Symptoms of carpal tunnel syndrome were associated with physical exposures in this prospective cohort study. This cohort is currently undergoing follow-up testing with measures of nerve conduction; future analyses will utilize these data in the case definition.

**Keywords:** Personal risk factors for MSD, Epidemiology, Carpal tunnel syndrome

### References:

US Department of Labor, Employment and Training Administration; 2007 [updated 2007; accessed on 15 January 2010]; Available from: [www.onetcenter.org](http://www.onetcenter.org).

Armstrong T, Dale AM, Franzblau A, Evanoff BA. Risk factors for Carpal Tunnel Syndrome and median neuropathy in a working population. *Journal of Occupational and Environmental Medicine* 2008 Dec; 50(12):1355-64.



## OXYGENATION AND HEMODYNAMICS FOR REPETITIVE WORK AND MUSCLE PAIN

### **Symposium Description**

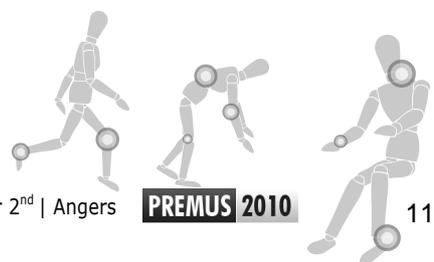
Despite that the physiological mechanisms behind work-related pain syndromes is unknown, prevalent findings from biopsies and laser Doppler studies in the 1990s and early 2000s indicate impaired regulation of the microcirculation, lower blood flow and reduced oxidative capacity of the muscle. The mechanism of how the condition develops, as well as the mechanism of the pain status are focuses of current research. Recent studies are emerging that are looking specifically at oxygenation and hemodynamics either during simulated-work in the laboratory or for real work at the job site for healthy subjects in order to obtain some predictive information for subsequent pain development. The intent of this symposium is to provide a state-of-the-art update of experimental designs and/or new techniques that address hemodynamics and oxygenation of relevance for investigating mechanisms behind work-related muscle pain and fatigue development.

### **Symposium Author**

Dr. Albert CRENSHAW

### **Authors linked to the symposium**

<b>Authors linked to the symposium</b>	<b>Name of their abstract</b>
ELCADI G.	Gender differences in the forearm for the oxygenation and myoelectric activity relation, muscle blood flow and oxygen consumption
JENSEN B.R.	Significance of muscle oxygenation levels for fatigue development during submaximal contractions
LYSKOV E.	Circulatory and electromyographic responses to physical effort and experimental pain in subjects with trapezius myalgia
KNARDAHL S.	Pain during office work: neck/shoulder pain and trapezius muscle blood flux during an experimental work session
CRENSHAW A.G.	Forearm oxygen delivery, consumption and blood flow before and after fatigue in subjects experiencing work related muscle pain and healthy controls
MAIKALA R.	Optical spectroscopy derived oxygen saturation responses of forearm muscles in healthy male workers during an eight hour exposure to a repetitive ulnar deviation task



## GENDER DIFFERENCES IN THE FOREARM FOR THE OXYGENATION AND MYOELECTRIC ACTIVITY RELATION, MUSCLE BLOOD FLOW AND OXYGEN CONSUMPTION

ELCADI G.H.<sup>1</sup>, FORSMAN M.<sup>2</sup>, CRENSHAW A.G.<sup>1</sup>

<sup>1</sup> Centre for Musculoskeletal Research, University of Gävle, Sweden – Department of Rehabilitation Medicine – Umeå University, Sweden - <sup>2</sup> Occupational and Environmental Medicine, Public Health Sciences, Institute Karolinska, Sweden.

### Aims:

The objective of this study was to investigate the relation between muscle oxygen saturation (StO<sub>2</sub>%) measured with near infrared spectroscopy (NIRS) and electromyography (EMG) in the extensor carpi radialis (ECR) of males and females during isometric contractions. Additionally by use of upper arm venous (VO) and arterial (AO) occlusions forearm muscle blood flow (BF) and oxygen consumption (mVO<sub>2</sub>) were determined, respectively. The ECR was of interest because it is prone to work-related muscle pain (WRMP). Gender differences were of special interest since females have a higher incidence of WRMP.

### Methods:

Fourteen males (26 ± 4 yrs) and fifteen females (26 ± 5 yrs) were equipped with probes for NIRS and EMG on the right ECR muscle. Isometric contractions (wrist extensions) of 10, 30, 50 and 70% MVC were performed. From contractions data the change in oxygen saturation percentage from baseline ( $\Delta$ StO<sub>2</sub>%) was calculated. EMG amplitudes (root mean square, RMS) were expressed as percentages of maximum. Slope values (k) between  $\Delta$ StO<sub>2</sub>% and EMG and correlation coefficients (R) were calculated for each subject. Next, with subjects in a reclined position VO (50 mmHg for 1 min) and AO (250 mmHg for 1 min) were done. For VO, slopes calculated from resting values for total hemoglobin were used to determine BF; for AO, slopes calculated for deoxyhemoglobin were used to determine mVO<sub>2</sub>. T-tests were used to compare mean value differences between genders.

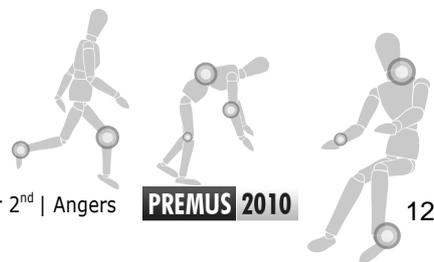
### Results:

The patterns observed for  $\Delta$ StO<sub>2</sub>%-EMG tended to differ between genders. Results for BF and mVO<sub>2</sub> revealed significant differences between males and females, see table.

### Conclusion:

Our findings indicate a gender specific relation between oxygenation and myoelectric activity as well as differences in blood flow and oxygen consumption in the ECR muscle. These data may be of importance for further investigating gender differences in WRMP.

**Keywords:** Mechanism of pain and tissue injury, Muscle activity, Gender differences.



## SIGNIFICANCE OF MUSCLE OXYGENATION LEVELS FOR FATIGUE DEVELOPMENT DURING SUBMAXIMAL CONTRACTIONS

JENSEN B.R., HAMMER C., HVITVED M.

Laboratory of Biomechanics and Motor Control, Department of Exercise and Sport Sciences, University of Copenhagen, Denmark.

### Aims:

Low levels of muscle oxygenation have been documented in myalgic muscles (1). The effect of low levels of muscle oxygenation for muscle fatigue is less clear. The myalgic muscle can be simulated in an upper-arm-cuff model. The aim was to study the effect of reduced muscle oxygenation on muscle endurance, performance and physiological signs of fatigue.

### Methods:

Twelve females (healthy-27yrs.) performed intermittent (15s-on/5s-off) isometric wrist extensions at 40%MVC to exhaustion (sitting position, horizontal forearm). The sessions were repeated twice; with and without 40mmHg upper-arm-cuff and also repeated on 2 different days. Exerted force, surface EMG (m. extensor carpi radialis(ECR), m. extensor digitorum(ED), m. brachioradialis(BR), m. biceps brachii(BB)) and tissue oxygenation (StO<sub>2</sub>(%StO<sub>2</sub>)) in ECR (NIRS) were recorded. Furthermore, heart rate and blood pressure were measured. Performance (steadiness) was evaluated as standard deviation of the exerted force (FSD). EMG recordings were used for calculation of EMG amplitude (EMGRMS(%EMGmax)) and mean power frequency (MPF(Hz)). Endurance was measured as time to exhaustion i.e. when 40%MVC exerted force could no longer be maintained.

### Results:

The cuff-model reduced ECR resting StO<sub>2</sub> from 81%StO<sub>2</sub> to 61%StO<sub>2</sub> and time to exhaustion was 8% (13.6min-vs-14.7min) shorter in cuff-sessions. StO<sub>2</sub> showed a clear difference between the two conditions. Thus, StO<sub>2</sub> decreased initially during the sessions to 45%StO<sub>2</sub> (no-cuff) and 23%StO<sub>2</sub> (cuff) and increased gradually during the sessions to 72%StO<sub>2</sub> (no-cuff) and 45%StO<sub>2</sub> (cuff). The 40% MVC wrist extension corresponded to 50N. FSD increased from 1.3N (cuff) and 1.1N (no-cuff) initially, to 4.9N (cuff) and 4.6N (no-cuff) at the end of the endurance session. The major FSD increase occurred earlier with cuff than without cuff. EMGRMS increased gradually from 43%EMGmax (no-cuff) and 43%EMGmax (cuff) to 66%EMGmax and 64%EMGmax for the ECR muscle. MPF for ECR decreased from 99Hz to 83Hz (no-cuff) and 101Hz to 84Hz (cuff). Similar pattern was seen for ED and BR. Thus, no clear effect of the cuff was seen on the EMGRMS and MPF. Heart rate and blood pressure response did not differ between conditions.

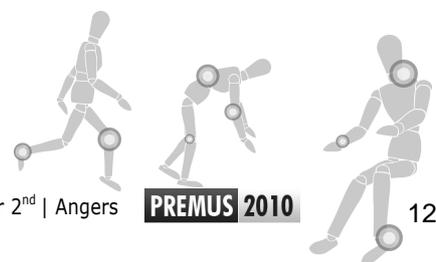
### Conclusion:

Low levels of muscle tissue oxygenation reduced endurance time and impaired mechanical muscle performance earlier in the cuff-sessions, despite no clear difference was seen in the EMG.

**Keywords:** Mechanism of pain and tissue injury, Muscle activity, Upper limb.

### Reference:

Jensen BR, Krag IR, Bronée L. Tissue oxygenation and hemoglobin kinetics among healthy subjects and computer users with work related shoulder/neck pain. 2007; PREMUS, p254, Boston.



## CIRCULATORY AND ELECTROMYOGRAPHIC RESPONSES TO PHYSICAL EFFORT AND EXPERIMENTAL PAIN IN SUBJECTS WITH TRAPEZIUS MYALGIA

HALLMAN D., LYSKOV E., GÖRAN LINDBERG L.

*Centre for Musculoskeletal Research, University of Gävle, Sweden*

### **Aims:**

Changes in muscle activity and blood flow due to stress and unfavorable muscle loads are factors behind work-related muscle pain. A possible mechanism may act via aberration of the ANS in form of elevated sympathetic activity (Passatore and Roatta 2006; Visser and van Dieën 2006). Therefore, the present study aimed to investigate autonomic regulation in relation to muscle activity, blood flow and symptoms in subjects with trapezius myalgia and healthy controls.

### **Methods:**

23 subjects with trapezius myalgia (females = 22) and 21 age- and gender-matched healthy controls (females = 20) participated in a laboratory experiment with quiet rest, hand grip test (HGT) and cold pressor test (CPT). Physiological activity were assessed continuously through heart rate variability (HRV) and blood pressure as well as by local recordings of muscle activity and blood flow using EMG and photoplethysmography, respectively, of the upper part of the trapezius muscle.

### **Results:**

The pain group showed reduced HRV during rest and increased low-frequency (LF) HRV in response to static contraction, without any significant differences during CPT. The pain group also showed elevated local muscle activity directly following static contraction and during CPT compared with controls. The pain group showed a reduced blood flow response to HGT on both sides. During CPT, the pain group showed slightly reduced blood flow for the contralateral side only. Pearson's correlations revealed a positive relation between LF-HRV reactivity to HGT and self rated disability.

### **Conclusion:**

Subjects with trapezius myalgia had elevated muscle activity and reduced blood flow during autonomic provocations compared with controls. HRV analyses indicated that subjects with trapezius myalgia had an autonomic state of increased sympathetic tone and vagal withdrawal during rest and increased sympathetic dominance during physical effort, compared with controls. Altogether, these results can be of importance for effective treatment of trapezius myalgia, maybe through interventions aiming at improving autonomic balance.

**Keywords:** Mechanism of pain and tissue injury, Neck, Pain, chronic pain.

### **Reference:**

Passatore M, Roatta S (2006) Influence of sympathetic nervous system on sensorimotor function: whiplash asso  
Visser B, van Dieën JH (2006) Pathophysiology of upper extremity muscle disorders. *Journal of Electromyography and Kinesiology* 16: 1-16



## **PAIN DURING OFFICE WORK: NECK/SHOULDER PAIN AND TRAPEZIUS MUSCLE BLOOD FLUX DURING AN EXPERIMENTAL WORK SESSION**

STRØM V., KNARDAHL S.

*National Institute of Occupational Health, Oslo, Norway*

### **Aims:**

The overall objective of this study was to elucidate the significance of muscle activity and microcirculation in the shoulder muscles as possible mechanisms underlying development of pain in the shoulders and neck during office work.

### **Methods:**

We established a computer-based work task which models office work (text editing). The task comprised a 90 min work without pauses, and with high hand precision demands and time pressure. Twenty-four subjects with chronic shoulder and neck pain, and 28 healthy pain-free reference subjects were recruited. The measurements included ratings of pain intensity, pressure pain thresholds (PPT), intramuscular trapezius blood flux by laser-Doppler flowmetry (LDF), and trapezius muscle activity by surface electromyography (EMG).

### **Results:**

The subjects, both with and without shoulder and neck pain, developed substantial pain during the work task and PPTs decreased from pre- to post-task similarly in both groups. The level of muscle activity was very low during the task (< 4% of EMG during maximal voluntary contraction). The LDF revealed local vasodilation throughout the work task in both groups. No significant correlations were found between pain and muscle activity. There were positive correlations with pain and blood flux in the pain-afflicted subjects and negative correlations in the reference group. For both groups this correlation became stronger with the time spent on the work task.

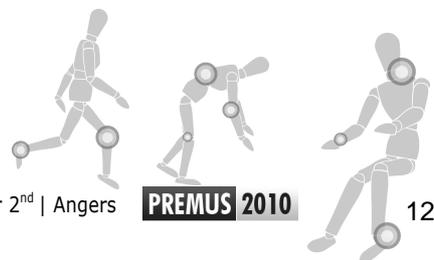
### **Conclusion:**

The findings suggest that office work involving time pressure and precise hand movements may induce substantial shoulder and neck pain and deep tissue hyperalgesia both in healthy pain-free subjects and in people with chronic shoulder and neck pain. This pain development seems to be related to the microcirculation of the upper trapezius muscles and not to the muscle activity.

**Keywords:** Mechanism of pain and tissue injury, Muscle activity, Neck.

### **Reference:**

Strøm V, Røe C, Knardahl S (2009): Work-induced pain, trapezius blood flux, and muscle activity in workers with chronic shoulder and neck pain. *Pain*, 144:147-155.



## FOREARM OXYGEN DELIVERY, CONSUMPTION AND BLOOD FLOW BEFORE AND AFTER FATIGUE IN SUBJECTS EXPERIENCING WORK RELATED MUSCLE PAIN AND HEALTHY CONTROLS

CRENSHAW A.G., ELCADI G.H.

Centre for Musculoskeletal Research, University of Gävle, Sweden – Department of Rehabilitation Medicine – Umeå University, Sweden.

### Aims:

Near infrared spectroscopy (NIRS) can be used in conjunction with upper arm venous (VO) and arterial (AO) occlusions to obtain information on forearm muscle oxygen delivery, blood flow (BF) and oxygen consumption (mVO<sub>2</sub>). The objectives of this study are: 1) to determine if these parameters differ between a group suffering from forearm pain and healthy subjects; 2) to determine the impact of fatigue on recovery of parameters for each group.

### Methods:

The study groups consist of 15 subjects, confirmed by physician examination to be experiencing chronic forearm muscle pain (> 3 months) related to their work, and 15 healthy subjects (gender and age matched) for the control group. The experimental protocol includes measurements at four time-points: baseline, immediately after fatigue, 15 min post, and 30 min post. At baseline with subjects in a reclined position VO (50 mmHg for 1 min) and AO (250 mmHg for 1 min) are performed. VO is also done for the other three time-points. For VO, the slopes calculated from resting values for NIRS-derived total hemoglobin are used to determine BF, and slopes calculated for deoxyhemoglobin are used to determine mVO<sub>2</sub>. For AO the slope of recovery of oxygen saturation following cuff ischemia determines oxygen delivery. The fatigue test entails subjects maintaining 15% of their individual maximum force (visually assisted) until force drops to 20% of the target. A two-way ANOVA incorporating group and time-point as main effects will be used to analyze data.

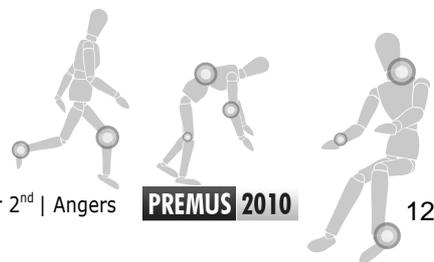
### Results:

This study is ongoing with data collection; however, results will be available and presented at the meeting.

### Conclusion:

While the mechanisms behind work-related muscle pain are unclear, previous studies show reduced blood flow (measured directly by laser Doppler), disturbed oxidative metabolism (via biopsy evaluation) and enhanced muscle fatigue associated with suffers. The present study introduces NIRS as a non-invasive reliable method capable of providing oxygenation and hemodynamic data of relevance for investigating such mechanisms.

**Keywords:** Mechanism of pain and tissue injury, Upper limb, Pain, chronic pain.



## OPTICAL SPECTROSCOPY DERIVED OXYGEN SATURATION RESPONSES OF FOREARM MUSCLES IN HEALTHY MALE WORKERS DURING AN EIGHT HOUR EXPOSURE TO A REPETITIVE ULNAR DEVIATION TASK

MAIKALA R.V., CIRIELLO V.M., O'BRIEN N.V., BANKS J., RIVARD A.J.

Center for Physical Ergonomics, Liberty Mutual Research Institute for Safety, Hopkinton, USA.

### Aims:

Psychophysically chosen acceptable torques (PAT) for repetitive hand tasks in the female industrial population were established previously (Ciriello et al., 2001). However, PAT values for male workers have yet to be reported. It is also unknown how torques generated during a hand task might influence muscle metabolic responses in the upper extremity. The purpose was to evaluate muscle oxygen saturation of fourteen men at their individual PAT during a hand task.

### Methods:

First, participants (mean  $\pm$  SD, age:  $41 \pm 15$  years; height:  $177 \pm 8$  cm, and body mass:  $79 \pm 11$  Kg) chose their PAT for a task that demanded ulnar deviation with a power grip at a frequency of 25 repetitions per minute in a seated posture over an eight-hour shift. On a subsequent day, near-infrared spectroscopy was utilized to determine the Oxygenation Index from the carpi ulnaris flexor and extensor muscles while participants performed the task at their individual PAT. At the end of the 8th hour, oxygen supply to both muscles was restricted for a minute via cuff occlusion to establish a reduced ischemic condition.

### Results:

Participants' PAT was  $3.57 \pm 2.7$  N.m. The figure below demonstrates the Oxygenation Index (%), representative of muscle oxygen saturation, from two muscles over an eight-hour shift. The greatest desaturation during exposure was observed in the extensor muscle.

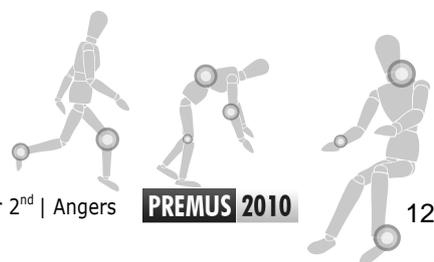
### Conclusion:

A steady contribution of the extensor was evident throughout (see Figure), however the prominent recruitment of the flexor as the exposure reached 8 hours implies the heterogeneity in metabolic demand between the two muscles. Since the Oxygenation Index for two muscles never reached values obtained during ischemic conditions, our results suggest that participants could perform the psychophysically chosen work without anoxia or localized muscle fatigue.

**Keywords:** Muscle activity, Postures, physical exposure, Upper limb.

### Reference:

Ciriello VM, Snook SH, Webster BS, and Dempsey P. Psychophysical study of six hand movements. *Ergonomics*. 2001;44:922-936.



## PAIN AND MOVEMENT

### **Symposium Description**

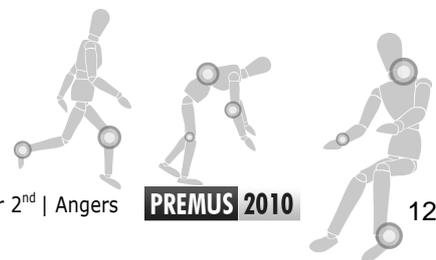
This symposium will provide the participants with the latest knowledge concerning the effects of fatigue, discomfort and pain on the motor system. First, the relationship between physical work load and musculoskeletal disorders will be reviewed. Then, recent findings regarding changes in motor performance at work in relation to fatigue, discomfort and pain will be discussed. The presentations will cover both low-back and shoulder regions in relation to static (e.g. computer work) and repetitive work (e.g. slaughterhouse). A special emphasis will also be given to the spatial activation pattern of erector spinae and trapezius muscles. Participants will gain valuable knowledge about exposure assessment in relation to work-related musculoskeletal disorders.

### **Symposium Author**

Prof. Pascal MADELEINE

### **Authors linked to the Name of their abstract symposium**

VEIERSTED B.	A review of epidemiological evidence for relationship between physical work load and musculoskeletal disorders
CÔTÉ J.	Work-work-work: individual joint- and whole-body changes associated with repetitive motion-induced fatigue
MADELEINE P.	On the transition from acute to chronic neck-shoulder pain in repetitive work
VOLLENBROEK- HUTTEN M.	Motor performance in chronic low back pain
HOLTERMANN A.	Trapezius activity distribution: relevance for pain?



## A REVIEW OF EPIDEMIOLOGICAL EVIDENCE FOR RELATIONSHIP BETWEEN PHYSICAL WORK LOAD AND MUSCULOSKELETAL DISORDERS

VEIERSTED K.B., KNARDAHL S.

*National Institute of Occupational Health, Oslo, Norway*

### **Aims:**

The Norwegian Labour Inspection and the Petroleum Safety Authorities have established a general aim for knowledge based practice in inspections and legislation. For that purpose they have asked the Norwegian NIOH to perform a critical systematic review of evidence for work related musculoskeletal disorders (MSD). The aim of this paper is to summarize the main findings concerning physical (mechanical) work load and MSD's.

### **Methods:**

The search strategy consisted of 5 clusters of terms that all should be present; exposure (e.g. work or occupation), effect type (e.g. pain), effect region (e.g. elbow), study designs (e.g. intervention) and exclusion terms (e.g. cancer). Based on these criteria approximately 22.000 papers published up to 15th October 2008 were found in Pubmed and EMBASE. Inclusion criterion was an original paper in English describing an epidemiological study that related any kind of work related exposure to any MSD. The main exclusion criteria were a cross-sectional design and a return-to-work design. The included papers were quality assessed by two independent researchers using a check list (Ariëns 2000). The papers of highest quality were used as reference when evaluating the evidence of a causal relationship (Knardahl et al. 2008).

### **Results:**

The mean score of quality for the 239 ultimately included papers found by these means, was 55% of the maximal possible score (range 27-88%). 85 papers achieved a quality score 60% or higher and these were included as background for the main conclusions below.

- Heavy physical work increase risk of shoulder, neck, low back, hip and knee disorders (However: some, but insufficient, documentation on specific work load components or relation to individual capacity)
- "Controlled" heavy lifting is well tolerated related to low back pain (LBP), but may be a risk combined with bending and twisting of truncus (awkward postures)
- Forceful person handling by lifting, pushing and pulling increase risk of LBP
- Elevated arms without support but with hands above shoulder or especially with elbow above shoulder level increase the risk of shoulder disorders. > ½ hour daily should be avoided.

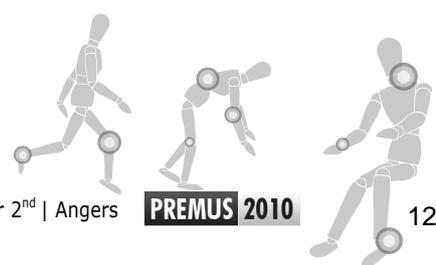
### **Conclusion:**

Methodological aspects of the systematic review, e.g. the sensitivity to detect relevant documentation will be discussed at the conference.

**Keywords:** Mechanism of pain and tissue injury, Postures, physical exposure, Epidemiology.

### **References:**

Ariëns GAM, van Mechelen W, Bongers PM, Bouter LM, van der Wal G. 2000. Physical risk factors for neck pain. *Scand J Work Environ Health* 26:7-19.  
Knardahl S. et al. Work as a cause of musculoskeletal disorders. Knowledge status 2008. (in Norwegian). STAMI-report nr 22, 2008.



## WORK-WORK-WORK: INDIVIDUAL JOINT- AND WHOLE-BODY CHANGES ASSOCIATED WITH REPETITIVE MOTION-INDUCED FATIGUE

CÔTÉ J.N., FULLER J.R., EMERY K.

*Department of Kinesiology and Physical Education, McGill University, Montreal; Michael Feil and Ted Oberfield/CRIR Research Centre, Jewish Rehabilitation Hospital, Laval, Canada*

### Aims:

Movement repetition and muscle fatigue are often mentioned in the etiology of work-related musculoskeletal disorders (WMSD) of the neck-shoulder. We have previously shown that repetitive motion-induced upper trapezius muscle fatigue leads to task-specific posture-movement adaptations that reduce the load on the fatigued structures and increase the contribution of remote joints and muscles to the task. We then sought to 1) describe the temporal aspects of these changes, and 2) determine the impact of fatigue on proprioceptive characteristics, so as to further understand the mechanisms underlying repetitive motion-induced fatigue.

### Methods:

Healthy adults completed a repetitive reaching task (RRT) to fatigue, the dominant arm moving at shoulder height (Fuller et al., 2009). EMG was collected from the reaching arm's upper trapezius, and tridimensional kinematics was collected to quantify endpoint (index finger), arm and center-of-mass (COM) average position and range of motion (ROM) throughout movement cycles. In study 1, the within-cycle interjoint timing sequence, cycle-to-cycle variability and overall time at which changes occurred during the RRT were determined for each parameter. In study 2, before and after the RRT, subjects performed trials, eyes closed, where they reached to a memorized target placed within the RRT trajectory or abducted their upper arm to their perceived horizontal.

### Results:

The RRT was performed for  $\approx 8$ min, with increased trapezius EMG RMS ( $\approx 47\%$ ) indicating fatigue at RRT's end. In study 1, trapezius EMG increases occurred at about 66% of RRT duration while other changes occurred from 29 to 53%. Cycle-to-cycle variability of elbow and shoulder average positions, and of elbow, shoulder and COM ROM increased with fatigue. However, endpoint kinematic characteristics were not affected. Also, peak arm and COM velocities occurred more simultaneously with fatigue. In study 2, subjects significantly underestimated target height when they reached with their finger; however they abducted above horizontal when fatigued.

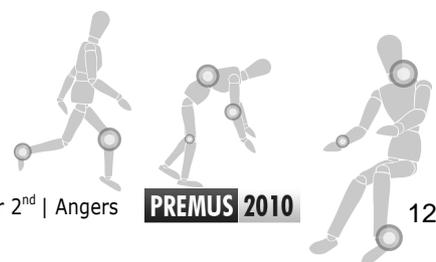
### Conclusion:

Results show that repetitive motion-induced fatigue involves whole-body changes that 1) begin to occur well before task termination, 2) are not only spatial but also temporal in nature, 3) could be related to differences in local (shoulder) vs global (endpoint) proprioceptive differences in the fatigue response. This suggests that not only spatial (e.g. posture, ROM) but also temporal and proprioceptive characteristics of repetitive tasks should be included in neck-shoulder WMSD prevention, rehabilitation and return-to-work strategies.

**Keywords:** Biomechanics, Muscle activity, Postures, physical exposure.

### Reference:

Fuller J, Lomond KV, Fung J, Cote JN. Posture-movement changes following repetitive motion-induced shoulder muscle fatigue. *J Electromyogr Kinesiol.* 2009;19(6):1043-52.



**ON THE TRANSITION FROM ACUTE TO CHRONIC NECK-SHOULDER PAIN IN REPETITIVE WORK**

MADELEINE P.

Laboratory for Ergonomics and Work-related Disorders, Center for Sensory-Motor Interaction (SMI), Dept. of Health Science and Technology, Aalborg University, Aalborg, Denmark

**Aims:**

Work-related musculoskeletal disorders (WMSD) have tremendous socio-economical effects. Recurrent episodes of acute pain from deep structures may lead to chronic pain located in e.g. the shoulder girdle. Moreover, the non specificity of WMSD calls for additional studies investigating the functional adaptations in work-related pain conditions that may help to delineate transition from acute to chronic pain conditions.

**Methods:**

Cross-sectional and longitudinal studies were conducted. Butchers with/without neck-shoulder pain (sub-chronic/chronic stages and controls) and healthy subjects (with/without acute pain) performed low load repetitive work in laboratory settings [1, 2]. Timing, electromyography (EMG) and 3D kinematics data were collected. The mean and the variability of the work cycle duration, the amplitude and ratio of EMG activity as well as the range of motion and its variability were computed

**Results:**

In presence of acute pain, the work cycle duration decreased while its variability increased, the level of EMG activity was lower and the arm and trunk' range of motion and variability increased compared with no pain ( $P<0.05$ ). In sub-chronic pain conditions, the work cycle duration increased, the level of EMG activity was lower and the arm/trunk' range of motion decreased/increased while the variability was smaller compared with no pain ( $P<0.05$ ). In presence of chronic pain, the work cycle duration decreased while its variability increased, the EMG activity pattern was more static and the arm and trunk range of motion increased while the variability decreased compared with no pain ( $P<0.05$ ).

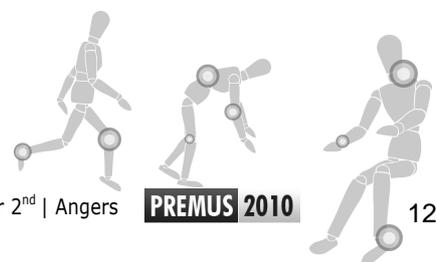
**Conclusion:**

The present results underlined interactions between work-related pain and motor strategies during dynamic repetitive task. These functional changes confirmed the importance of the known physical risk factors like repetitiveness, EMG activity level, posture and movement. Moreover, these results pointed towards important relation between motor variability and pain status underlining the importance of motor variability during repetitive work. This may have clinical implications for the prevention and treatment of WMSD.

**Keywords:** Biomechanics, Muscle activity, Pain, chronic pain.

**References:**

- [1] Madeleine P, Voigt M, Mathiassen SE. Cycle to cycle variability in biomechanical exposure among butchers performing a standardized cutting task. *Ergonomics*. 2008; 51(7):1078-95.  
 [2] Madeleine P, Mathiassen SE, Arendt-Nielsen L. Change in the degree of motor variability associated with experimental and chronic neck-shoulder pain during a standardized repetitive arm movement. *Exp Brain Res*. 2008;185:689-98.



**MOTOR PERFORMANCE IN CHRONIC LOW BACK PAIN**

VOLLENBROEK-HUTTEN M.M.R., HERMENS H.J., HULST VAN DER M., VAN WEERING M.

*Roessingh Research and Development, Enschede, The Netherlands***Aims:**

Management of chronic low back pain (CLBP) is difficult because of insufficient knowledge about the mechanisms how chronic pain is developed and maintained. Starting from the general accepted biopsychosocial character of chronic pain, more insight in the physical functioning of CLBP is considered to be one of the aspects that needs to be explored in more detail. The aim of this study is twofold. One to investigate whether there is a difference in daily activity patterns between CLBP patients and non-symptomatic controls and the other to investigate whether CLBP patients show deviations in trunk muscle activity during walking on a treadmill, when compared to a-symptomatic controls.

**Methods:**

Two cross-sectional studies were performed. In study 1, sixty-three subjects with CLBP and thirty-three a-symptomatic controls walked on a treadmill at different velocities. Surface electromyography data of the erector spinae -, rectus abdominis- and obliquus abdominis externus muscles were obtained and averaged per stride and expressed in SRE values. In study 2, 29 CLBP patients and 20 controls wore a tri-axial accelerometer for seven consecutive days during waking hours to assess their daily activities. These signals were filtered and averaged to obtain an activity level per hour.

**Results:**

Study 1 showed that for both the back and abdomen muscles the mean SRE values were significantly higher in subjects with CLBP than in controls both during periods of double support and swing [2]. In addition results show that in the back muscles the alteration in muscle activity between periods of swing and double support is not different between both groups [1].

Results of study 2 show that the total amount of activities on a day is not significantly different from those of controls. However, patients show a deviating trend over the day with significantly higher activity levels in the morning ( $p < 0.001$ ) and significantly lower activity levels in the evening ( $p < 0.01$ ) compared to controls [3].

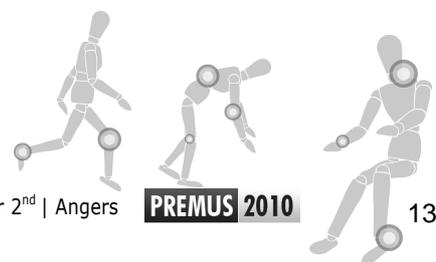
**Conclusion:**

Based on these results, it can be concluded that patients with chronic low back pain show altered physical performance during every day life which is reflected in a muscle guarding of back and abdomen muscles during walking as well as a decline in daily activity patterns over the day. This knowledge can be used as starting points for the development of new treatment approaches consisting of monitoring and feedback on their daily performance.

**Keywords:** Mechanism of pain and tissue injury, Muscle activity, Back, low back.

**References:**

- [1] van der Hulst M, Vollenbroek-Hutten MM, Rietman JS, Schaake L, Groothuis-Oudshoorn KG, Hermens HJ. Clin J Pain. 2010 Jan;26(1):30-7  
 [2] van der Hulst M, Vollenbroek-Hutten MM, Rietman JS, Hermens HJ. J Electromyogr Kinesiol. 2010 Feb;20(1):31-8.  
 [3] Weering MG van, Vollenbroek-Hutten MM, Tönis TM, Hermens HJ. Eur J Pain. 2009;13(6): 649-54.



## TRAPEZIUS ACTIVITY DISTRIBUTION: RELEVANCE FOR PAIN?

HOLTERMANN P., WAKEFIELD E., JARLE MORK P.

*National Research Centre for the Working Environment, Copenhagen, Denmark*

### **Aims:**

The spatial distribution of trapezius activity is shown to be modified with fatigue and biofeedback training. Moreover, the distribution of trapezius activity is modulated with local injection of hypertonic saline and local delayed onset muscle soreness (DOMS) under laboratory settings. However, it is unknown whether acute trapezius pain induced by DOMS changes the habitual trapezius activity during real-life situations. The aim of the present study was to investigate the effect of acute trapezius pain on habitual trapezius activity during unconstrained daily activities.

### **Methods:**

Long-term (5 hrs) surface electromyographic (sEMG) activity was recorded bilaterally from the clavicular, descending, transverse, and ascending trapezius on two consecutive weekdays in eleven female subjects (mean age 22 years, range 20-24 years). Body and arm posture were recorded by inclinometers. Immediately after the first long-term recording, the subjects performed eccentric depression exercise of the left shoulder to induce DOMS

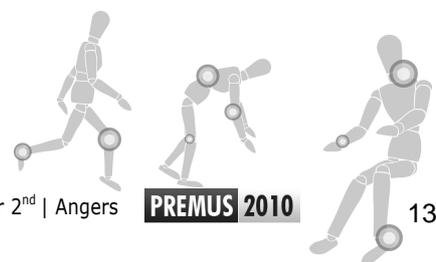
### **Results:**

From day 1 to day 2, pressure pain threshold decreased and pain scored on visual analogue scale increased for the left upper trapezius. Habitual sEMG activity (median sEMG level,  $\mu\text{V}$ ) of the clavicular and descending part of the left trapezius increased from first to second long-term recording during periods with seated posture ( $P < 0.05$ ). Trapezius sEMG activity remained unchanged for all other trapezius parts and postures.

### **Conclusion:**

This study indicates that acute trapezius pain induces elevated habitual trapezius activity during periods with low biomechanical loading of the shoulder/neck muscles with the elevated sEMG activity being restricted to the painful upper part of the trapezius muscle.

**Keywords:** Muscle activity, Postures, physical exposure, Neck.



## RATIONALIZATION TRENDS IN WORKING LIFE: CHALLENGES AND OPPORTUNITIES TO CREATE SUSTAINABLE PRODUCTION SYSTEMS

### **Symposium Description**

Medical conditions diagnosed as musculoskeletal or mental disorders are a major cause of sick leave, threatening the welfare of individuals and the economics of companies and the society. Several reviews suggest that mechanical risk factors play only marginal roles in the primary development of musculoskeletal disorders. In addition, numerous reviews on primary ergonomic intervention research have problems in showing long-term effects on musculoskeletal or mental disorders. Most guidelines to practitioners suggest a main focus on interventions directed towards return-to-work initiatives, physical exercise and other initiatives at the individual level.

This Symposium initially presents insights from research fields of work sociology, organization science, HRM management, and economics illustrating mostly negative effects of current rationalization on musculoskeletal and mental health and corresponding risk factors (Westgaard & Winkel). The overview will also point at how these effects can be modified.

A case study of Home Care Workers by Robstad Andersen & Westgaard shows that the effects of ergonomic workplace interventions carried out on local levels may be nullified by the introduction of larger organizational changes (rationalizations).

Prospective studies of rationalization in public dental care show the impact of organizational and technical rationalizations on productivity, physical environment, psychosocial conditions and sick-leave (Rolander et al). The consequences of the rationalizations on the mechanical exposures among the dentists are presented by Jonker et al.

Consequences of rationalization on physical workload in different manufacturing industries are presented by Arvidsson et al as well as Forsman et al based on 5 different case studies.

Based on all the above presentations it is concluded that production system rationalization represents a pervasive work life intervention without a primary occupational health focus. It has mostly negative influence on worker health and risk factors. Tools and methodologies should be developed that allow concurrent tuning of performance and wellbeing considerations in a rationalization process towards "sustainable production systems", here defined as the joint consideration of competitive performance and working conditions in a long term perspective. Along this line Jarebrant et al present a tool for considering mechanical and mental work content in the production flow of both services and goods. Finally, Caroly et al present results illustrating how to manage negative effects on operators' health and safety when introducing Lean principles in manufacturing industry.

The symposium concludes by a plenum discussion on how the presented evidence could be used as a basis for new priorities in ergonomic intervention research for musculoskeletal health.

### Part I

#### Introduction (*Winkel*)

1<sup>st</sup> presentation: Occupational musculoskeletal and mental health: significance of rationalization and opportunities to create sustainable production systems – a systematic review (*Westgaard & Winkel*)

2<sup>nd</sup> presentation: Lean Production and Work-related Musculoskeletal Disorders, WMSDs (*Armstrong*)

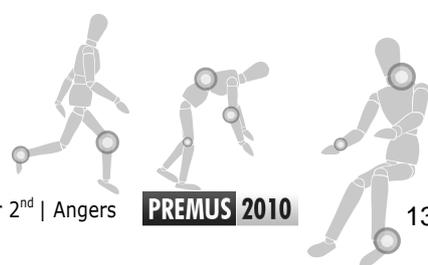
3<sup>th</sup> presentation: Employee appraisal of workplace intervention effects. Preliminary results from a study of 6 units within the Home Care Services in Norway (*Robstad Andersen & Westgaard*)

4<sup>th</sup> presentation: Rationalization in public dental care and its impact on working conditions, productivity and health of dentists – a prospective study (*Rolander et al*)

5<sup>th</sup> presentation: Rationalisation in public dental care and impact on biomechanical exposures for dentists - a prospective study (*Jonker et al*)

### Part II

6<sup>th</sup> presentation: Consequences of rationalization on physical workload in meat cutting (*Arvidsson et al*)



7<sup>th</sup> presentation: Rationalization in manufacturing industry as a key determinant of mechanical Exposures: case studies of parallel and serial flow production (*Forsman et al*)

8<sup>th</sup> presentation: A tool for considering mechanical and mental work content in the production flow of services and goods (*Jarebrant et al*)

9<sup>th</sup> presentation: Sustainable MSD prevention: management for continuous improvement between prevention and production. Ergonomic intervention in two assembly line companies (Caroly et al)

Plenum discussion: New priorities in ergonomic intervention research for musculoskeletal health

### **Symposium Author**

WINKEL J.<sup>1</sup> AND WESTGAARD R.H.<sup>2</sup>

<sup>1</sup> National Research Centre for the Working Environment, Copenhagen, Denmark and Department of Work Science, University of Gothenburg, Sweden – <sup>2</sup> Dept. of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Trondheim, Norway

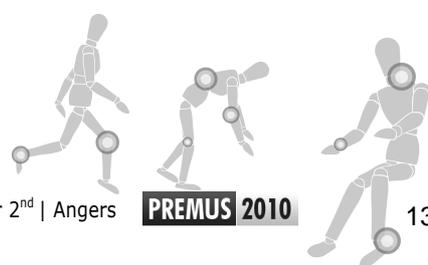
### **Authors linked to the Name of their abstract symposium**

#### **Part I**

WESTGAARD R H	Occupational musculoskeletal and mental health: significance of rationalization and opportunities to create sustainable production systems – a systematic review
ARMSTRONG T. ANDERSEN G	Lean production and work-related musculoskeletal disorders, WMSDs Workplace intervention effects: organizational level discrepancies and interferences? Preliminary results from a study of 6 units within the home care services in Trondheim, Norway
ROLANDER B	Impact on working conditions, productivity and health of dentists – a prospective study during rationalizations in public dental care
JONKER D	Rationalization in public dental care and impact on biomechanical exposures for dentists – a prospective study

#### **Part II**

ARVIDSSON I	Consequences on physical workload of rationalization in meat cutting
FORSMAN M	Rationalization as a determinant of mechanical exposure – case studies of parallel and serial flow production in two auto branches at different levels of industrialization
JAREBRANT C	A tool for development of sustainable health care systems by integrating considerations for performance and job content
CAROLY S	Sustainable MSD prevention: management for continuous improvement between prevention and production. ergonomic intervention in two assembly line companies



## OCCUPATIONAL MUSCULOSKELETAL AND MENTAL HEALTH: SIGNIFICANCE OF RATIONALIZATION AND OPPORTUNITIES TO CREATE SUSTAINABLE PRODUCTION SYSTEMS – A SYSTEMATIC REVIEW

WESTGAARD R.H.<sup>1</sup>, WINKEL J.<sup>2</sup>

<sup>1</sup> Dept. of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Trondheim, Norway -

<sup>2</sup> National Research Centre for the Working Environment, Copenhagen, Denmark and Department of Work Science, University of Gothenburg, Sweden

### Aims:

This literature review aims to identify occupational musculoskeletal and mental health effects of production system rationalization as well as organizational-level measures that may improve health outcome (“modifiers” in this review).

### Methods:

A short review of the effect of ergonomic interventions is included as background and rationalization is discussed as a theoretical concept. Indicator variables for occupational musculoskeletal and mental health and related risk factors are presented. Variables with a generalized format were allowed in the literature searches (e.g., job satisfaction and absenteeism were accepted as risk factor and health indicator, respectively), suitable for the research fields of work sociology, organization science, human resource management (HRM) and economics research.

### Results:

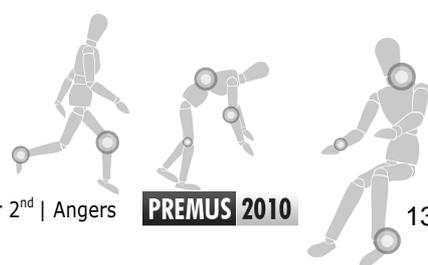
One hundred and sixty-two studies of rationalization effects on health and risk factors and 72 organization-level modifier results were accepted into the final database. Entries were sorted by rationalization strategy and work life sector, and trends in outcome (positive, mixed, no effect, or negative effect on health and risk factors) were determined.

Rationalizations have a dominant negative effect on health and risk factors (57% negative, 19% positive); the most negative effects were found for downsizing and restructuring rationalizations in general (71 studies negative, 13 positive) and for the health care sector in particular (36 studies negative, 2 positive). The rationalization strategy High Performance Work System (HPWS) was associated with the highest fraction positive outcome studies (6 of 10 studies). Other rationalization strategies (lean practices, parallel vs. serial production and mechanization level) reported intermediate results, in part dependent on work life sector, but also on the year when studies were carried out. Worker participation, resonant management style, information, support, group autonomy and procedural justice are modifiers with favourable influence on outcome.

### Conclusion:

It is concluded that production system rationalization represents a pervasive work life intervention without a primary occupational health focus. It has considerable and mostly negative influence on worker health, but this can be reduced by attention to modifiers. The results create a basis for new priorities in ergonomic intervention research

**Keywords:** Work organization, Intervention studies, Intervention methods.



## LEAN PRODUCTION AND WORK-RELATED MUSCULOSKELETAL DISORDERS, WMSDS

ARMSTRONG T.J.

Center for Ergonomics, University of Michigan

### Aims:

This paper examines the relationship between lean manufacturing and WMSD risk factors.

### Methods:

To achieve this aim, we examine first some early experiences with lean manufacturing in the and second some possible effects of the "seven-deadly wastes" on productivity and WMSD risk factors.

### Results:

Elements of lean manufacturing can be traced to the use of stopwatches and standardize work by Taylor (Kanigel 1997); to methods analysis and motion economy (Gilbreth et al. 1953); the assembly line, specialized tooling and continuous improvement by Ford (Brinkley 2003); and the Toyota Production System, TPS (Liker 2004). Lean has done much to reduce production costs. With continuous improvement Ford reduced the time to build Model Ts from 12.5 man-hours in 1908 to 1.5 hours in 1914 (Brinkley 2003). Some of the improvements that helped to minimize costs also helped to reduce ergonomic stresses. Henry Ford has been quoted "No worker must ever have to stoop to attach a wheel, bolt, screw, or anything else to the moving chassis" (Burlingam 1966). As the auto industry became more competitive, increasing work rates contributed to unionization of the autoworkers. Fucini and Fucini (1992) described how Kaizen and the leaning of jobs contributed to increased WMSD rates at Ford-Mazda plant. Lewchuk and Robertson 1996, Landsbergis et al. 1999 and Conti et al. 2006 reported associations between workers' perception of stress and lean production methods. Womack et al (2009) reported slightly lower hand force and repetition in a lean auto plant than in a conventional plant.

TPS recognizes "seven deadly wastes." These include: 1) over production 2) unnecessary transportation 3) inventory, 4) motion, 5) defects, 6) over processing and 7) waiting (Liker 2004). Some of these, such as reducing inventories, can reduce cost of acquiring and storing materials and reduce bending, reaching, forceful exertions. Pull, just-in-time production and one-piece flow help to minimize the work-in-process, but they require precise estimates of work and recovery times. Minimizing "motions" will save time and can result in more recovery time. Reducing "waiting" may increase production rates, but it reduces recovery time.

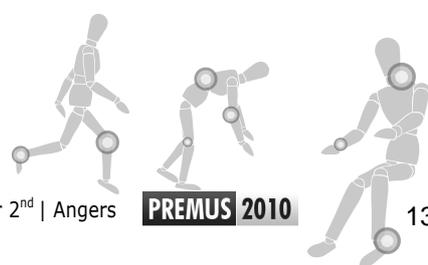
### Conclusion:

Lean methods have been shown to increase productivity, but they may increase or decrease WMSDs. WMSDs should be added to the list of "deadly wastes." Improved models are needed to predict required work and recovery times.

**Keywords:** Postures, physical exposure, Work organization, Intervention methods.

### References:

- Brinkley D. *Wheels for the World: Henry Ford, His Company, and a Century of Progress*. New York, NY, Viking, 2003.  
Liker J. *The Toyota Way: 14 Management Principles From The World's Greatest Manufacturer*. New York, McGraw-Hill, 2004, pp. 28-29.  
Womack S, Armstrong T, Liker J. "Lean job design and musculoskeletal disorder risk: A two plant comparison." *Human Factors and Ergonomics in Manufacturing* 2009;19(4): 279-293.



## **WORKPLACE INTERVENTION EFFECTS: ORGANIZATIONAL LEVEL DISCREPANCIES AND INTERFERENCES? PRELIMINARY RESULTS FROM A STUDY OF 6 UNITS WITHIN THE HOME CARE SERVICES IN TRONDHEIM, NORWAY**

ANDERSEN G.R., WESTGAARD R.H.

*Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Trondheim, Norway*

### **Aims:**

Unhealthy time pressure was recognized in 2004 as a critical stressor for Home Care Workers (HCWs) in the municipality of Trondheim, Norway. The council implemented a number of interventions on local and municipal levels, representing a considerable effort in terms of allocated resources (estimated monetary costs 15 mill NOK), to reduce such time pressure and thereof a high level of sick leave. The study aims to examine the effects of the interventions in terms of reduced time pressure and sick leave, how implementation was evaluated on different organizational levels, and whether organizational changes for different purposes, carried out simultaneously, interfered with the outcome.

### **Methods:**

In spring 2009, questionnaires were distributed to a total of 181 HCWs in 6 different units in the Home Care Services. 138 questionnaires were returned, a response rate of 76.2%. In depth interviews were carried out on municipal (N=3), unit manager (N=5) and shop floor level (N=17). Statistics on annual sick leave rate 2004-2008 were collected for each unit through the council's records on sick leave.

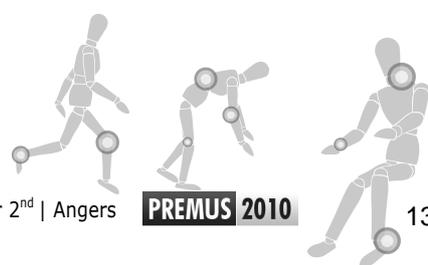
### **Results:**

75.7% of HCWs in all units reported increased time pressure, and statistics on sick leave showed an increase in average sick leave rate. Differences were observed between the units. The unit reporting the highest increase in time pressure ( $F(5,124) = 3.62; p < .01$ ) also evaluated the interventions to be less successful compared to the other units. In addition, this unit had the highest increase in sick leave rate (36.4% in 2008 vs. 15.2% in 2004). The actual unit was subjected to a merger in this period, and qualitative responses point at this being a cause of additional strain and time pressure. There appears to be an organizational level discrepancy in perceptions regarding causes of time pressure and reasons for lack of intervention success, such as an increase in workload and a reduction in resources such as staff, time and money.

### **Conclusion:**

Overall, interventions aimed at decreasing unhealthy time pressure among the HCWs appear to lack a positive effect. The effects of workplace interventions seem to be nullified by the introduction of larger organizational changes such as, in this case, unit mergers. Also, rationalization interventions aimed at improving efficiency by standardization of work tasks may have resulted in reduced porosity, leading to an increase in HCW perception of time pressure. Such perception is disavowed at higher organizational level in the municipality.

**Keywords:** Health care workers, Work organization, Intervention studies.



## IMPACT ON WORKING CONDITIONS, PRODUCTIVITY AND HEALTH OF DENTISTS – A PROSPECTIVE STUDY DURING RATIONALIZATIONS IN PUBLIC DENTAL CARE

ROLANDER B.<sup>1,2</sup>, JONKER D.<sup>1,2</sup>, BALOGH I.<sup>3</sup>, SANDSJÖ L.<sup>4</sup>, WINKEL J.<sup>5</sup>, SVENSSON E.<sup>1</sup>, EKBERG K.<sup>1</sup>

<sup>1</sup> Dept Health & Med & HELIX, Linköping Univ, Sweden – <sup>2</sup> Futurum, Sweden – <sup>3</sup> Dept Occup & Environ Med, Lund Univ, Sweden – <sup>4</sup> Occup & Environ Med, Univ Gothenburg, Sweden – <sup>5</sup> National Research Centre for the Working Environment, Copenhagen, Denmark & Dept Work Sci, Univ Gothenburg, Sweden

### Aims:

During the last decade organizational and technical rationalizations have been implemented in public dentistry in many countries, often with negative impact on work conditions. Dental care in Jönköping County Council/Sweden implemented the following organizational and technical rationalizations during the period 2003 to -08:

- Computerization of clinical case books and booking of patients
- Reorganization into smaller units and introduction of one more management level
- Digital X-ray
- SMS reminders to patients to reduce missed appointments
- A new IT-system to enable online communication between healthcare providers and insurance funds
- Self-registration by patients on a screen on arrival to the clinic.

The aim of the present study was to analyze associations between dentists working conditions, health and production during technical and organizational rationalizations between 2003 and 2008.

### Methods:

The design is a prospective cohort study; dentists in public dental care responded to web-based questionnaires in 2003 and 2008. A total of 121 dentists responded in 2003 (response rate: 80%) and 114 dentists in 2008 (response rate 74%), 65 dentists responded at both occasions and constitute the empirical material in this study. The questionnaire comprised items on work postures, precision demands, work control, musculoskeletal complaints, physical and mental ability, and sick leave. Data on number of treated patients and planned treatment time was gathered from existing records at the dental office. Changes over time were analyzed with paired t-test, and direct and indirect paths between the different indices with Structural Equation Modeling (SEM).

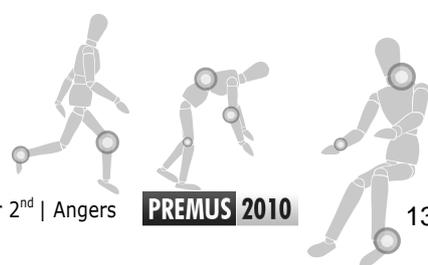
### Results:

The SEM-analyses showed that precision demands increased strenuous work postures, which had negative effects on sick leave, ability and production/dentist in 2003. These paths were similar but less clear for 2008. There were significant improvements in work conditions between 2003 and 2008 in terms of reduced precision demands and strenuous work postures ( $p < .001$ ) (cf. Jonker et al, the present Symposium), and production increased ( $p < .02$ ). Perceived work control was reduced ( $p = .01$ ) and leadership deteriorated ( $p = .02$ ).

### Conclusion:

During the investigated period of rationalizations in dentistry productivity per dentist increased and the physical environment improved, possibly due to increased delegation of dental work to other professional groups (see also Jonker et al, this Symposium). The paths between physical work conditions, health and productivity did not change over time. Reported musculoskeletal disorders had little effect on sick leave or production. It is notable that work control and leadership deteriorated, but there was no paths to health or productivity during the studied period.

**Keywords:** Postures, physical exposure, Health care workers, Work organization.



## RATIONALIZATION IN PUBLIC DENTAL CARE AND IMPACT ON BIOMECHANICAL EXPOSURES FOR DENTISTS – A PROSPECTIVE STUDY

JONKER D.1,2, ROLANDER B.1,2, BALOGH I.3, SANDSJÖ L.4, EKBERG K.1, WINKEL J.5

<sup>1</sup> Dept Health & Med & HELIX, Linköping Univ, Sweden – <sup>2</sup> Futurum, Sweden – <sup>3</sup> Dept Occup & Environ Med, Lund Univ, Sweden – <sup>4</sup> Occup & Environ Med, Univ Gothenburg, Sweden – <sup>5</sup> NRCWE, Denmark & Dept Work Science, Univ Gothenburg, Sweden

### Aims:

During decades public dentistry has been rationalized in many countries, often with negative impact on work environment.

Technical and organizational changes were implemented in public Dental care in Jönköping County Council/Sweden during the period 2003 to 2008 (see Rolander et al, this Symposium).

The aim of the present study was to evaluate how these rationalizations affect the proportion of 'non-value-added work' ('waste') and biomechanical exposures of dentists during work.

### Methods:

From a sample of 12 dentists in public dental care, data were collected during four hours of an ordinary working day by means of video recordings and direct technical measurements of biomechanical exposures in year 2003 and 2009. Work activities were analysed during 45 minutes of the video recordings from each subject by means of a computerized video activity analysis system. The categorization of work tasks into waste and 'non-waste' was conducted based on a list of coded work activities according to the zero-based analysis (Engström et al 1997).

The biomechanical exposures were assessed by inclinometers recording flexion/extension of head and trunk and elevation of upper arm. The exposures were computed for each work activity. Changes over time were analyzed using Wilcoxon signed ranks tests and paired t-test.

### Results:

Our preliminary results indicate that the duration of waste tended to increase from 43% year 2003 to 55% year 2008 ( $p=0,1$ ). 'Patient treatment' and 'administration', comprising about half the working time, became less dynamic (reduced mean movement velocities and changes of these for the investigated body parts). 'Handling of materials/parts' showed the opposite changes. In general, the biomechanical exposures during waste were interpreted as less riskful for development of MSD compared to non-waste.

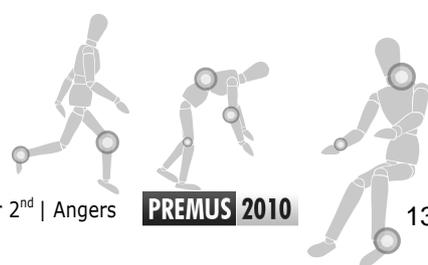
### Conclusion:

The investigated rationalizations did not show further reduction in waste and no obvious work intensification commonly described in the literature when introducing Lean and New Public Management.

Non-waste work activities implied, for both year 2003 and 2009, more strenuous postures for the head and back compared to the waste activities. In general, the biomechanical job exposures (pooled waste and non-waste activities) did not change from 2003 to 2009.

This lack of work intensification seems partly to agree with the self-assessed physical exposures among the dentists in Jönköping reported by Rolander et al. (this Symposium).

**Keywords:** Postures, physical exposure, Health care workers, Work organization.



## CONSEQUENCES ON PHYSICAL WORKLOAD OF RATIONALIZATION IN MEAT CUTTING

ARVIDSSON I., BALOGH I., HANSSON G.Å., OHLSSON K., SKERFVING S., NORDANDER C.

*Division of Occupational Environmental Medicine, Lund University, Sweden*

### Aims:

Meat cutting has been associated with a high incidence of musculoskeletal disorders. Traditionally, industrial meat cutters work in individual piece-rate salary-systems, with a high work pace, awkward postures and high grip forces. The development of new production systems points to an increase of automatic processes; halved bodies of pork are cut by an electrical saw into sixth-parts, resulting in smaller meat-parts and shorter work-cycles for the workers. Recently, machine-directed line-production has been implemented, implying even shorter work-cycles. How the physical workload is influenced by the changes in production systems is largely unknown. This study aims to evaluate the physical workload with emphasis on differences between and variations within pork cutting of half-parts, sixth-parts and line-production.

### Methods:

The physical workload was recorded by technical measurements in workers performing pork-cutting of half-parts (piece-rate, cycle-time 4-5 minutes; n = 5), sixth-parts (piece-rate, 0.7-3 minutes; n = 10) and line-production (eight work stations, 0.2-0.5 minutes; n = 5), during one workday/individual. Postures and movements in head, back and upper arms were measured by inclinometry and in wrists/hands by goniometry. The muscular activities (% of maximal voluntary contraction; MVE) and time proportion of muscular rest (<0.5% MVE) in the trapezius and forearm extensors were measured by electromyography. Further, the variation in upper arm postures was quantified "within minutes" and "between minutes".

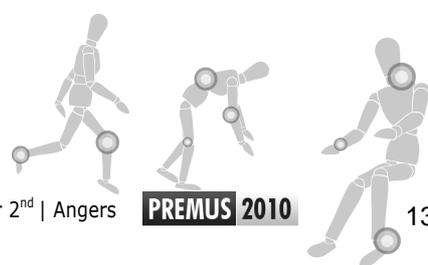
### Results:

The physical workload was highest in the half-part system and lowest in the line-production. For example, the movement velocities for the upper arm (50th percentile) were 209°/s in half-part, 103°/s in sixth-part and 81°/s in line-production. The muscular activity in the forearm extensor muscles (50th percentile) was 24% MVE, 13% MVE and 9% MVE, respectively. However, the differences between the sixth-part and the line-production systems were not statistically significant. In line-production, the physical workload at the eight work stations differed slightly. The workers in the half-part system had the highest variation of the upper arm postures within minutes (indicating a high range of motion), but the lowest between minutes (indicating a low variation during the workday), while the other systems did not differ significantly.

### Conclusion:

The physical workload in the line-production was less demanding than in the half-part system, and to some extent also as in the sixth-part system. However, there may be disadvantages in line-production work, in terms of machine-directed work pace, shorter cycle-times and loss of occupational skills.

**Keywords:** Muscle activity, Postures, physical exposure, Work organization



## RATIONALIZATION AS A DETERMINANT OF MECHANICAL EXPOSURE – CASE STUDIES OF PARALLEL AND SERIAL FLOW PRODUCTION IN TWO AUTO BRANCHES AT DIFFERENT LEVELS OF INDUSTRIALIZATION

FORSMAN M.<sup>1</sup>, PALMERUD G.<sup>2</sup>, NEUMANN W.P.<sup>3</sup>, WINKEL J.<sup>4</sup>

<sup>1</sup> Dept Public Health Sci, Karolinska Inst, Sweden – <sup>2</sup> Dept Occup & Environ Med, Univ Gothenburg, Sweden – <sup>3</sup> Dept Mech & Ind Eng, Ryerson Univ, Toronto, Canada – <sup>4</sup> NRCWE, Copenhagen, DK, & Dept Work Science, Univ Gothenburg, Sweden

### Aims:

After years of parallelised flows with long-cycle times in Sweden, companies now tend to design more conventional serial flow production (Wallace 2008). The purpose of the present study was to investigate differences in mechanical exposure between the two production strategies considering differences in industrialization level.

### Methods:

Direct measurements of body postures and velocities as estimates of risk for developing MSD were carried out:

- In a Swedish engine assembly factory ('high industrialization level'), a parallel – and a new serial-based system were compared.
- In car disassembly ('low industrialization level'), a Swedish traditional craft-type system (Kazmierczak et al., 2005) was compared with a new Dutch serial-flow system.

Video recordings were used to estimate the duration of direct work and waste. Forward/backward bending of the head and back, and arm elevation were measured with inclinometers, and wrist positions with biaxial electrogoniometers, for six hours per worker. The exposure parameters included the 50th percentiles of median body angles and velocities.

### Results:

The waste time was lowest for 'high industrialization level' (see Table). The Swedish 'low industrialization' disassembly was characterised by high profitability and low demands for reduction in waste time (waste: 72% of working time). The Dutch car disassembly system increased speed of body movements, but was unsuccessful in reducing waste; it was still 'immature'.

Table. Waste time and exposure in the four cases. The stars indicate significant differences between cases at the same industrialization level. In parallel assembly the operators could stop after a quota. This incentive to work fast was eliminated in the serial system, in which also pauses were induced due to system losses.

Measurements	Low industrialization level (car disassembly)		High industrialization level (engine assembly) (n=6)	
	Parallel (n=10)	Serial (n=8)	Parallel	Serial
Waste (% of work time)	72	69	50	25
Head forward bending (°)	19.5	23.4	24.7	21.2
Head velocity (°/s)	19.6	38.7 ★	19.2 ★	17.2
Back forward bending (°)	10.1	17.2 ★	3.8	2.8
Back velocity (°/s)	14.7	23.5 ★	17.8 ★	13.8
Dominant arm elevation (°)	32.0	36.3	31.3	31.5
Dominant arm velocity (°/s)	23.6	41.5 ★	29.5 ★	24.9

### Conclusion:

Production strategy seems to play a significant role in determination of mechanical exposures through differences in control systems that determine work pace. 'Low industrialization level' is partly reflected in poor back posture.

**Keywords:** Postures, physical exposure, Work organization, Intervention studies.

### References:

Kazmierczak K, Mathiassen SE, Forsman M, Winkel J. An integrated analysis of ergonomics and time consumption in Swedish 'craft-type' car disassembly. *Applied Ergonomics* 2005;36:263-273.  
Wallace T. Cycles of production: from assembly lines to cells to assembly lines in the Volvo Cab Plant. *New Technology, Work and Employment*. 2008;23:111-124.



## A TOOL FOR DEVELOPMENT OF SUSTAINABLE HEALTH CARE SYSTEMS BY INTEGRATING CONSIDERATIONS FOR PERFORMANCE AND JOB CONTENT

JAREBRANT C.<sup>1,2</sup>, DUDAS K.<sup>3</sup>, HARLIN U.<sup>2,4</sup>, JOHANSSON HANSE J.<sup>5</sup>, WINKEL J.<sup>1,6</sup>

<sup>1</sup> University of Gothenburg, Department of Work Sciences, Sweden – <sup>2</sup> Swerea IVF AB, Mölndal, Sweden – <sup>3</sup> Sahlgrenska Hospital & University of Gothenburg, Sweden – <sup>4</sup> Chalmers University of Technology, Gothenburg, Sweden – <sup>5</sup> University of Gothenburg, Department of Psychology, Sweden – <sup>6</sup> NRCWE, Copenhagen, Denmark.

### Aims:

In a recent review by Westgaard and Winkel (this Symposium) it is concluded that ergonomic interventions in general seem to have limited, if any positive health effects in a long range perspective. In contrast, rationalization of production systems mostly has negative effects on musculoskeletal and mental health and corresponding risk factors. However, these effects may be modified by good leadership and fair treatment, focusing those aspects that favour worker participation and dialogue between workers and management. The aim of the present investigation was therefore to modify the key Lean process tool Value Stream Mapping (VSM) to a tool simultaneously considering musculoskeletal and mental health issues ('Ergo-VSM') to facilitate the development of sustainable systems. Several reports indicate that application of VSM may imply reduced opportunities for mental and physical recovery (reduced "porosity") and thus cause "work intensification" (e.g. Green 2004). This presentation focuses development and preliminary evaluation of a prototype (Ergo-VSM-JC) considering Job Content in relation to elimination of waste within Swedish health care.

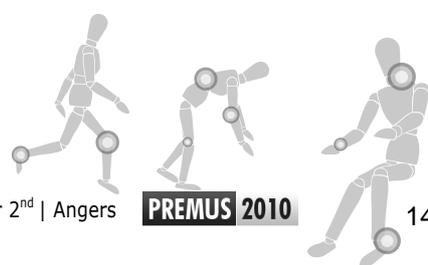
### Methods:

Ergo-VSM is based on a paper-and-pencil procedure aiming to facilitate a participatory intervention process, previously shown to be crucial for modifying potential negative ergonomic effects of rationalization. The intention is that employees should be able to assess existing as well as planned flows. ErgoVSM-JC is used to assess issues of work characteristics and job design by using an 'objective' methodological approach that focus upon job content. The frame of reference is the Demand-Control model (Karasek & Theorells, 1990) and the Job Demands-Resources model (JD-R model) (Bakker & Demerouti, 2007). The JD-R model includes various types of job demands and resources depending on the occupational context under study. ErgoVSM-JC is also influenced by other tools already in use in the field of ergonomics, for example VIDAR/PSIDAR (Johansson Hanse & Forsman, 2001) and ARIA (Waldenström & Härenstam, 2008). But the uniqueness of ErgoVSM-JC is that the tool is integrated with VSM. The present version considers job demands, resources (job control, communication/social interaction), job content potential, mental porosity and mental/content job variation on task, flow and job level. ErgoVSM-JC is developed in an iterative process in co-operation with end users.

### Conclusion:

At a qualitative level the tool has shown to act as a strong catalyst in the process of developing solutions along the line of increased sustainability.

**Keywords:** Health care workers, Work organization, Intervention methods.



## **SUSTAINABLE MSD PREVENTION: MANAGEMENT FOR CONTINUOUS IMPROVEMENT BETWEEN PREVENTION AND PRODUCTION. ERGONOMIC INTERVENTION IN TWO ASSEMBLY LINE COMPANIES**

CAROLY S., COUTAREL F., LANDRY A., CHERAY I.

*PACTE, University of Grenoble, France- Clermont University- ARACT*

### **Aims:**

Prevention would be more efficient if health were incorporated in the tools and indicators used to run companies. Most actors do not realise that there is a link between health and production. The aim of this presentation is to analyse the conditions required for this safety/production logic approach to be integrated in the "continuous improvement" systems of French industry.

### **Methods:**

Both companies work in similar sectors: assembly of parts. The first company had a prevention approach that was not linked to the production management system. The other company had a Kaizen production management system but not really prevention approach. The comparison of the two companies involved the following: analysis of health, safety and production report; interviews with several stakeholders; observations of work situations, committee and working group. The first company was followed for 30 days and the second company for 10 days.

### **Results:**

In first study, it appeared necessary to develop ergonomic integration for the industrialisation of new products. For example, it was found that a gap of 5 millimetres in diameter between the utensil and packing box required workers to exert considerable pressure in order to insert the utensil into the box. The fit between the packaging and the utensil was only checked at the launch of the new range. No prototype was used. The economic cost of loss production and the effect of workers health are important.

In second study, the disjunction between prevention-based logic and production-based logic can be explained by implemented easily and quickly solutions with little cost. This management method is above all controlled by the goal of higher productivity. For example, Kaizen approach underline the divide between the philosophy and the reality of actions. Health was not considered to be as important as quality or production. In the end, the decrease in work spaces with the organisational changes contributed to increasing MSD (biomechanical constraints).

### **Conclusion:**

Some actions will improve the meeting between quality, ergonomics, productivity and safety :

- a policy based on integration and compromise between different forms of logic in the company
- the training of all the actors (management, occupational health and safety committee, human resources manager, operators, etc.) to encourage collective approach
- the ergonomic criteria using to specifications and tests before a product launch
- the assessment of actions operational problems

Such approach leads to more time consuming during projects. But time investment is largely offset later.

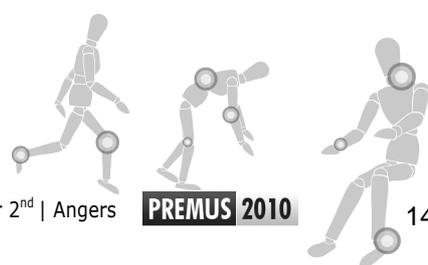
**Keywords:** Work organization, Intervention studies, Social aspects of MSD.

### **References:**

Winkel, J., Westgaard, R.H., 2008. Facteurs de risques de TMS au travail et perspectives de solutions : passé, présent, avenir. HESA Newsletter 34, Juin 2008, 3-7.

Jörgen, A., Eklund, E., 1995. Relationships between ergonomics and quality in assembly work. Applied Ergonomics 26 (1), 15-20

Kuorinka, I., 1998. The influence of industrial trends on work-related musculoskeletal disorders (WMSDs). International Journal of Industrial Ergonomics 21, 5-9



## **ROUND TABLE DISCUSSION PART I. CLASSIFICATION OF MUSCULOSKELETAL DISORDERS IN OCCUPATIONAL HEALTH PRACTICE AND RESEARCH: WHEN IS PREVENTIVE ACTION IN OH REQUIRED? AND DISTINGUISHING BETWEEN NORMAL AND SERIOUS SYMPTOMS**

### ***Description***

Part I:

Organizers: Mats Hagberg, Francesco Violante, Roberta Bonfiglioli, Judith Sluiter

Chair: Mats Hagberg

In this first part, it will be discussed when preventive action in occupational health is required when musculoskeletal ill health / health problems are present. The question to be discussed, is: "What limit or severity of musculoskeletal ill health/ health problems in an individual worker or in a group of workers will require preventive action in occupational health?" Results of the session will be described in a consensus statement of the ICOH SC MSD

#### Intervenants:

Silverstein B

Bonfiglioli R

Rempel D

Sluiter J

Roquelaure Y

Part II:

Organizers Francesco Violante, Roberta Bonfiglioli, Mats Hagberg, Judith Sluiter

Chair: Francescor Violante

In this second part, the available instruments to distinguish "normal musculoskeletal symptoms" from "too serious musculoskeletal symptoms" in workers will be discussed with experts from the ICOH Scientific Committee Musculoskeletal disorders and interested researchers. The question to be discussed, is: "What reliable and valid instruments do we have in research to distinguish "normal musculoskeletal symptoms" from "too serious musculoskeletal symptoms" in workers? " Results of the session will be described in a consensus statement of the ICOH SC MSD.

#### Intervenants:

Eira Viikarii-Juntura

Paul Kuijer

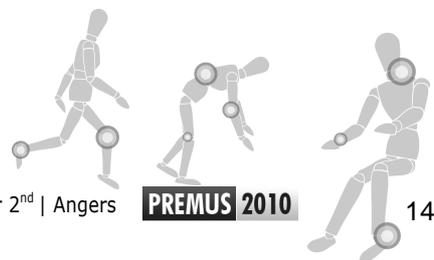
Roberta Bonfiglioli

Alexis Descatha

Laura Punnett

### ***Organizer***

Dr. Judith Sluiter



## **ROUND TABLE DISCUSSION PART II. CLASSIFICATION OF MUSCULOSKELETAL DISORDERS IN OCCUPATIONAL HEALTH PRACTICE AND RESEARCH: NEEDED IN THE FUTURE TO ADDRESS SUSTAINABLE MUSCULOSKELETAL HEALTH AND RELATED WORK ABILITY?**

### **Description**

In this round table session, the future of the use of classification systems of MSDs in occupational health care will be discussed with experts from the ICOH Scientific Committee Musculoskeletal disorders and interested researchers. The question to be discussed is: "What measures or classification system of musculoskeletal health do we need in the near future to address sustainable musculoskeletal health and related work ability?" Results of the session will be described in a consensus statement of the ICOH SC MSD.

### **Organizers**

Judith Sluiter, Francesco Violante, Roberta Bonfiglioli, Mats Hagberg

### **Chair**

Judith Sluiter

### **Intervenants**

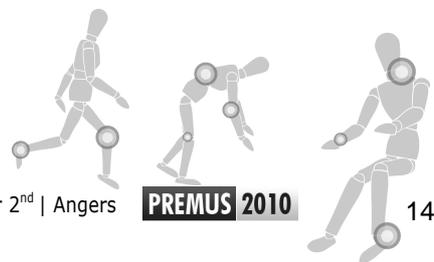
Yves Roquelaure

Brad Evanoff

Monique Frings-Dresen

Judy Gold

Mats Hagberg



## **SURVEILLANCE OF WORK-RELATED MUSCULOSKELETAL DISORDERS: HOW? BY AN FOR WHOM? HOW IS IT LINKED TO PREVENTION?**

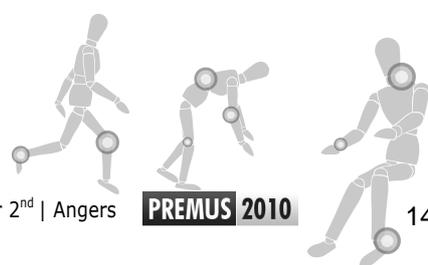
This symposium will describe different approaches to work-related musculoskeletal disorders (WMSD) surveillance in different jurisdictions in France, Canada and the USA. By "WMSD Surveillance" we are referring to the analysis of administrative data (e.g. medical services, compensation, disability system), survey data (health surveys, working conditions surveys) or active surveillance data reported by occupational health physicians or medical specialists to identify the prevalence or incidence of various MSD that are presumed to be due to or aggravated by work and/or the prevalence of work exposures known to be risk factors for WMSD. Usually such surveillance aims to identify sub-groups at risk who should be targeted for prevention. Such studies may be part of a government-sponsored public health strategy for surveillance per se or for occupational health prevention or be carried out independently by university-based researchers. The context of this work may influence the resources and nature of the surveillance work conducted and its capacity to influence decision-makers and those carrying out WMSD prevention in the field. The symposium will describe several examples of what surveillance activities are being carried out, explore the methodological challenges faced, provide examples of results of surveillance and explore how these results are linked to prevention activities and how this process can be improved to better meet the needs of decision-makers and those carrying out prevention activities. The format includes 3 presentations describing 3 different approaches to WMSD surveillance activities and the challenges each faces, followed by a roundtable discussion with researchers, decision makers and others who are concerned by the use of surveillance data to orient prevention activities. The specific objectives are: 1. to describe different WMSD surveillance systems in place in France, Canada and the USA 2. to describe how results of WMSD surveillance studies are communicated and used in each of these jurisdictions 3. to describe how surveillance data is used in the field to identify groups at high risk of WMSD and/or to prioritize prevention activities 4. to identify the challenges in carrying out WMSD surveillance activities and linking those activities to WMSD prevention 5. to explore how WMSD surveillance activities may be improved to better meet the needs of decision makers who decide on priorities for prevention and the needs of those in the field carrying out prevention.

### **Symposium Author**

Dr. Susan STOCK

### **Authors linked to the Name of their abstract symposium**

STOCK S.	Work-related musculoskeletal disorders (WMSD) surveillance and Quebec's public health strategy to prevent wmsd: realizations and challenges.
SILVERSTEIN B.	Using workers compensation data for wmsd surveillance
HA C.	French epidemiological surveillance program of work-related musculoskeletal disorders: strengths and challenges



## WORK-RELATED MUSCULOSKELETAL DISORDERS (WMSD) SURVEILLANCE AND QUEBEC'S PUBLIC HEALTH STRATEGY TO PREVENT WMSD: REALIZATIONS AND CHALLENGES.

STOCK S.

Quebec Institute of Public Health (Institut national de santé publique du Québec) and School of Public Health, University of Montreal' Montreal, Québec, Canada.

### Aims:

This presentation will describe the Quebec public health system for occupational health (OH), how the prevention of WMSD is integrated into this system and the role of surveillance in the WMSD prevention strategy.

### Methods:

Prevention of WMSD is a public health priority in Quebec. Public health laws require surveillance of the population's health status and its determinants. The Quebec Institute of Public Health's Scientific Group on WMSD (SG-WMSD) has undertaken a range of epidemiologic surveillance activities including:

- the analysis of provincial workers' compensation data to identify sub-groups at high risk of WMSD who can be targeted for prevention;
- the development of WMSD-related outcome and exposure measures for and analysis of surveys including the 1998 Quebec Social and Health Survey, the 2007-2008 Quebec Survey of Working Conditions and Health and Safety, the 2008 Quebec Population Health Survey;
- development of tools for active surveillance by local and regional OH teams.

### Results:

The results may have influenced some priorities of Quebec's OHS Commission. A province-wide regional WMSD surveillance program has adapted the methods developed by the SG-WMSD for use by regional OH public health teams to identify industries at high risk of WMSD that can be targeted for preventive interventions by local teams. These activities are part of a broader plan of WMSD prevention based on recommendations on the role of public health in the prevention of WMSD. This recently developed program integrates identification of WMSD risk factors into OH preventive activities of local teams and is developing strategies for mobilising employers to address these MSD risks.

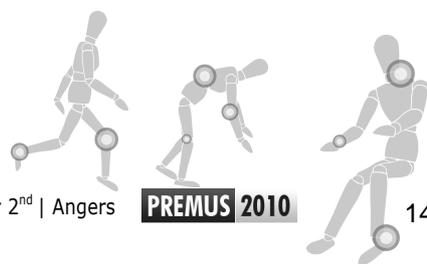
### Conclusion:

A number of challenges exist. While population-based survey data provides the most representative data of worker exposures and health problems, the number of respondents is often too low to adequately identify sub-sectors at risk of WMSD. The compensation data does allow identification of sub-sectors at risk of WMSD but the data is limited because of a high rate of underreporting. Regional and local OH teams are quite autonomous and province-wide programs are sometimes difficult to implement as planned. Nonetheless there is considerable commitment from regional OH coordinators to support the harmonized WMSD surveillance and prevention activities and a willingness on the part of local OH teams to implement the program. The potential for using WMSD surveillance data to prioritize local preventive interventions is recognised but not yet realised.

**Keywords:** Surveillance, Methods in epidemiology, Public policy.

### Reference:

Stock S, Caron D, Gilbert L, Gosselin L, Tougas G, Turcot A. La prévention des troubles musculo-squelettiques : réflexion sur le rôle du réseau de santé publique et orientations proposées pour la santé au travail. Institut national de santé publique du Québec et Agences de développement de réseaux locaux de services de santé et de services sociaux/Directions de santé publique, 2006.



## USING WORKERS COMPENSATION DATA FOR WMSD SURVEILLANCE

SILVERSTEIN B., ADAMS D.

Washington State Department of Labor and Industries, USA

### Aims:

Health Surveillance is the ongoing, systematic collection, analysis, and interpretation of health and hazard data essential to plan, implement, and evaluate prevention activities and getting information to those who need to know in order to act [1]. Prevention of work-related musculoskeletal disorders such as carpal tunnel syndrome and low back disorders has been a focus of international prevention efforts including regulation. We use Washington State WMSDs WC claims incidence rates to provide ongoing data from which to assess the need and the effects of prevention activities.

### Methods:

Washington State Fund workers compensation claims for general and selected specific hand/wrist, elbow, shoulder, and back disorders in 1999-2007 as well as general self-insured compensable (four or more lost workdays) claims data were examined. Payroll hours were used to calculate claims incidence rates per 10,000 full-time equivalent employees (FTEs). We created a prevention index (PI) to rank industries by averaging the ranks of their number of claims and their claims incidence rate.

### Results:

Between 1999-2007, there were 117,303 State Fund accepted upper extremity WMSD WC claims representing 10% of all claims, with an average claims incidence rate (CIR) of 61.6 and severity rate of 7,947 days per 10,000 FTEs and \$1.9 billion in direct costs. The claims incidence rate was 14.0/10,000 FTEs for rotator cuff syndrome (RCS), 7.4 for epicondylitis, 12.7 for tendinitis, 16.0 for CTS with respective severity rates of 3171, 864, 1546 and 2913 lost work days per 10,000 FTE respectively. Industry sector PI order was Construction, Manufacturing, Transportation & Utilities, Trade, Finance, Health Care, Mining and Agriculture.

Based on PI by WC State Fund risk class, the top 7 4-digit industries for upper extremity WMSDs were state patient/health care personnel, wallboard installation, non-wood frame building construction, trucking, roofing work, wood frame building construction and temporary help machine operators. These were similar for rotator cuff and epicondylitis. However, for tendinitis and CTS, barber and beauty shops, supermarkets, meat, fish & poultry wholesalers and plastic goods manufacturing, logging and metal goods manufacturing were added.

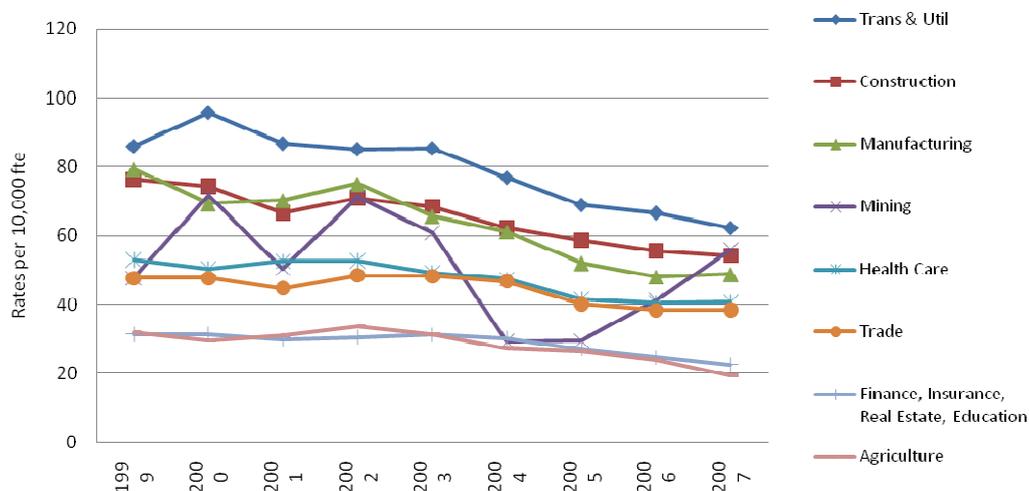


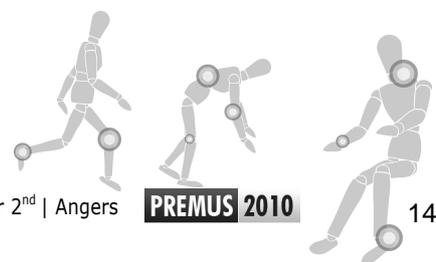
Figure 1. WA Compensable WMSD rates by industry, 1999-2007

### Conclusion:

WMSDs continue to be a large and costly problem in Washington State. The PI suggests manual handling work for RCS and epicondylitis but more hand intensive work for CTS and tendinitis. The PI is a useful way to prioritize prevention work.

### Reference:

[1] Stephen B. Thacker & Ruth L. Berkelman, Public Health Surveillance in the United States, 10 EPIDEMIOLOGIC REVIEWS. 164, 164 (1988) (quoting CTRS. FOR DISEASE CONTROL, COMPREHENSIVE PLAN FOR EPIDEMIOLOGIC SURVEILLANCE ii (1986)).



## FRENCH EPIDEMIOLOGICAL SURVEILLANCE PROGRAM OF WORK-RELATED MUSCULOSKELETAL DISORDERS: STRENGTHS AND CHALLENGES

HA C.<sup>1</sup>, BRIERE J.<sup>1</sup>, PLAINE J.<sup>1</sup>, FOUQUET N.<sup>1,2</sup>, ROQUELAURE Y.<sup>2</sup>, IMBERNON E.<sup>1</sup>

<sup>1</sup> Department of Occupational Health, French Institute for Public Health Surveillance, Saint-Maurice, France – <sup>2</sup> Laboratory of Ergonomics and Epidemiology in Occupational Health, University of Angers, Angers, France

### Aims:

An epidemiological surveillance pilot program for work-related musculoskeletal disorders (WRMSDs) was implemented in 2002 in France's Pays-de-la-Loire region to assess their incidence and prevalence in the general and working population, identify levels of exposure to occupational risk factors and investigate the proportion of cases that might be attributable to work exposure [1,2]. Estimations according to occupational categories and economic sectors of activity aimed at the prioritization of areas for preventive strategies. This program has contributed to a better description of WRMSDs in France, which until recently was mainly based on workers compensation data statistics. In order to make the burden of occupational factors more visible in the social debate and to facilitate the use of the epidemiological results by all the actors of occupational risks prevention (public institutions, social partners, companies, occupational physicians, workers...), we are working to build comprehensible, reliable and reproducible indicators.

### Methods:

Relative risks from the Maine-et-Loire study [2] were used to estimate the population-attributable fractions (PAF) of carpal tunnel syndrome (CTS) according to occupational categories and the number of surgical CTS cases that could be attributable to work on a national scale.

Sex-specific indicators of exposure to WRMSD risk factors according to occupational categories and economic sectors were constructed using a random sample of 3710 salaried workers [1]. These indicators were adjusted to be representative of the structure of the salaried worker population of the whole Pays-de-la-Loire region.

### Results:

PAF of CTS ranged from 16% to 33% in females clerks, from 8% to 16% in females blue-collar workers, and from 30% to 56% in male blue-collar workers. The estimated number of surgical CTS cases attributable to work ranged from 13,143 to 30,860 among female workers aged 20-59, representing from 22% to 51% of all surgical cases of this age group in France. Exposure indicators from the Pays-de-la-Loire region show that 24% of females (95% CI[22%-27%]) and 19% of males ([17%-20%]) were exposed to at least one extreme posture for >2 hours/day and a highly repetitive job for >4 hours/day, and 20% of females ([18%-22%]) and 17% of males ([15%-19%]) were exposed to at least one extreme posture, a highly repetitive job and a forceful exertion at work (>2 hours/day).

### Conclusion:

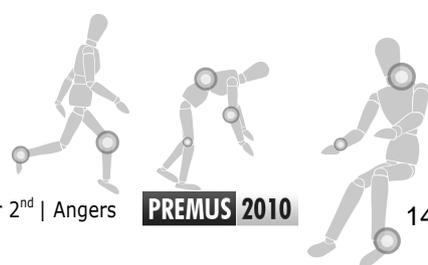
The strengths and current challenges faced by this program will be discussed. Other methods are currently being explored to make this epidemiological surveillance more efficient on a national scale, and make its results more helpful to establish preventive strategies.

**Keywords:** Epidemiology, Surveillance, Public policy.

### References:

[1] Ha C, Roquelaure Y, Leclerc A, Touranchet A, Goldberg M, Imbernon E. The French Musculoskeletal Disorders Surveillance Program: Pays de la Loire Network. *Occup Environ Med* 2009;66:471-9.

[2] Roquelaure Y, Ha C, Fouquet N, Descatha A, Leclerc A, Goldberg M, Imbernon E. Attributable risk of carpal tunnel syndrome in the general population: implications for intervention programs in the workplace *Scand J Work Environ Health* 2009;35(5):342-8.



## THE ROLE OF SELF-EFFICACY IN THE DISABILITY PREVENTION FRAMEWORK AND THE RETURN TO WORK PROCESS

### **Symposium Description**

Chairs: S. Brouwer & U. Bültmann

Self-efficacy has been an important theoretical construct for many decades, but it has only recently been highlighted in the return-to-work (RTW) literature. Several authors emphasize the role of self-efficacy in the work disability prevention framework and in the RTW process, however, a comprehensive understanding of the role of self-efficacy is still lacking.

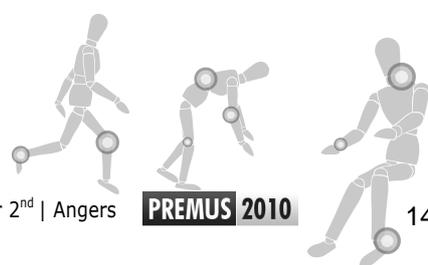
In this symposium, we will present results from four recently performed studies about self-efficacy. A presentation will be given about the development and pilot testing of a new (28-item) work self-efficacy scale that was administered to 400 US workers experiencing work-related low back pain (LBP). The relation of the scale to concurrent measures of pain, function, and well-being will be presented (Shaw). The second presentation addresses a study about the relationship of general and specific self-efficacy beliefs with functional capacity evaluation (FCE) performances in LBP patients (Reneman). Within the behavioral change models, self-efficacy is hypothesized to increase as an individual progresses to more advanced stages of readiness for change. The third study will address the association between self-efficacy and the readiness for RTW in a cohort of injured workers with work-related musculoskeletal conditions (Brouwer). In the fourth presentation "The role organizational policies and practices in determining changes in self efficacy in RTW" will be presented (Amick, Katz) among workers at 2 month post carpal tunnel release surgery. Overall, the presenters will discuss their findings with respect to the role of self-efficacy in the disability prevention framework and the return to work process.

### **Symposium Author**

Dr. Sandra BROUWER

### **Authors linked to the Name of their abstract symposium**

SHAW W.	Development of the return-to-work self-efficacy (RTWSE) questionnaire: psychometric properties and predictive validity
RENEMAN M.	General and specific self-efficacy reports of patients with chronic low back pain: are they related to performances in a functional capacity evaluation?
BROUWER S.	Association between self-efficacy and readiness for return-to-work in a cohort of injured workers with work-related musculoskeletal conditions
AMICK B.	The role of organizational policies and practices in effecting self-efficacy in return to work following carpal tunnel surgery



## DEVELOPMENT OF THE RETURN-TO-WORK SELF-EFFICACY (RTWSE) QUESTIONNAIRE: PSYCHOMETRIC PROPERTIES AND PREDICTIVE VALIDITY

SHAW W.S.<sup>1,2</sup>, LINTON S.J.<sup>3</sup>, HUANG Y.H.<sup>1</sup>, PRANSKY G.<sup>1,2</sup>

<sup>1</sup> Liberty Mutual Research Institute for Safety, Hopkinton, MASSACHUSETTS, USA – <sup>2</sup> University of Massachusetts Medical School, Worcester, MASSACHUSETTS, USA – <sup>3</sup> Orebro University, Orebro, Sweden

### Aims:

Poor expectations for recovery have been shown to be a self-fulfilling prophecy among working adults with low back pain (LBP), but more reliable and valid measures are needed to study the specific psychological mechanisms underlying this phenomena. Self-efficacy, the “belief in one’s abilities to organize and execute the courses of action required to produce given attainments”(Bandura,1997), may be a useful paradigm for understanding return-to-work efforts.

### Methods:

Based on qualitative results with back-injured workers (focus groups, n=28, and semi-structured interviews, n=23)(Shaw & Huang, 2005), the authors compiled a 28-item Return-to-Work Self-Efficacy (RTWSE) questionnaire with the goal of assessing perceived capabilities of patients to return to work within three conceptual domains: (1) meeting job demands; (2) controlling pain at work; and (3) obtaining help. The pilot scale was completed by 293 patients (61% male, mdn age 35) who were participating in an inception cohort study of acute, work-related LBP.

### Results:

The full response range (1-10) was utilized on all 28 items, and there were no ceiling or floor effects. Mean item scores ranged from 4.7 (“reducing physical workload”) to 8.3 (“describing injury to supervisor”). An exploratory factor analysis (using principal component with varimax rotation) supported 3 underlying factors (eigenvalues>1.0), but item loadings suggested an alternative labeling of: (1) meeting job demands (16 items); (2) modifying job tasks (8 items); and (3) communicating needs to others (4 items). Internal consistency (alpha) for the 3 scales were 0.98, 0.90, and 0.77, respectively. In week 2, mean self-efficacy scores improved for meeting job demands (6.3 vs. 5.6) and modifying job tasks (5.5 vs. 5.1), but not for communicating needs (6.9 vs. 7.0). At 3-month follow-up, both RTW (80%) and continuing work limitations were predicted by RTWSE assessed in week 2 (p<.05), but not RTWSE assessed in week 1.

### Conclusion:

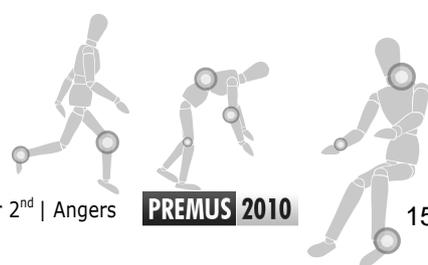
A final 16-item version of the RTWSE has adequate reliability and validity to assess the confidence of working adults with LBP to meet job demands, modify job tasks, and communicate needs to co-workers and supervisors. Administration in the second week after LBP onset may provide a more useful prognostic indicator. Future studies might test how RTWSE interacts with other prognostic factors to influence RTW outcomes.

**Keywords:** Psychosocial factors, Return to work, Back, low back.

### References:

Bandura A. Self-efficacy: The exercise of control. New York: WH Freeman; 1997. p 279-313.

Shaw WS, Huang YH. Concerns and expectations about returning to work with low back pain: Identifying themes from focus groups and semi-structured interviews. *Disabil Rehabil.* 2005;27:1269-81.



## **GENERAL AND SPECIFIC SELF-EFFICACY REPORTS OF PATIENTS WITH CHRONIC LOW BACK PAIN: ARE THEY RELATED TO PERFORMANCES IN A FUNCTIONAL CAPACITY EVALUATION?**

RENEMAN M.F., GEERTZEN J.H.B., GROOTHOFF J.W., BROUWER S.

*Center for Rehabilitation, University Medical Center Groningen, University of Groningen, The Netherlands.*

### **Aims:**

The objective of this study was to analyze the relationship of general and specific self-efficacy (SE) beliefs with functional capacity evaluation (FCE) performances in patients with chronic non-specific low back pain (CLBP), while controlling for influence of gender, age, and self-reported pain intensity, self-esteem, disability, psychosocial distress and health status.

### **Methods:**

Included were 92 patients with CLBP referred to an outpatient university based multidisciplinary pain rehabilitation program in The Netherlands. All patients underwent an FCE. General SE was measured with the ALCOS questionnaire prior to the FCE, specific SE was measured with a self-constructed standardized question during the FCE. Paired samples t-tests were used to test differences between predicted and actual performances. Pearson and Spearman rank correlation coefficients were used to express the strength of the relationships between SE and performances. Multivariate analyses were used to test the influence of control variables on the relationships between SE (general or specific) and performances.

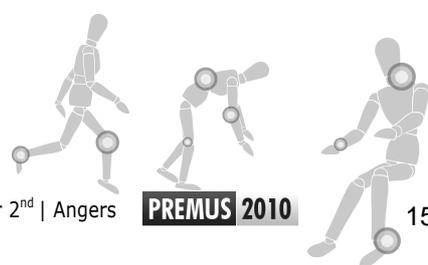
### **Results:**

Performances were consistently higher than patients' self-predictions. Differences between predictions and performances were significant in male lifting low, male carrying, and female carrying. With exception of the association between specific SE and lifting in males ( $r=0.55$ ,  $p<0.05$ ), all other correlations between general and specific SE and FCE performances were non-significant. Multivariable regression analyses showed that the relative contribution of SE measures over gender was little or none.

### **Conclusion:**

The contribution of specific SE to the prediction of FCE performances is moderate in one instance, and insignificant in most instances (both specific and general SE). Because of the consistency of the differences between prediction (specific SE) and performances, and depending on the level of accuracy needed, future research may deliberate the use of predicted material handling capacities at group level and correct for a systematic underprediction.

**Keywords:** Psychosocial factors, Return to work, Back, low back.



## ASSOCIATION BETWEEN SELF-EFFICACY AND READINESS FOR RETURN-TO-WORK IN A COHORT OF INJURED WORKERS WITH WORK-RELATED MUSCULOSKELETAL CONDITIONS

BROUWER S., FRANCHE R.L., HOGG-JOHNSON S., LEE H., KRAUSE N., SHAW W.S.

Department of Health Sciences, Work and Health, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands

### Aims:

Return to work (RTW) has been defined as a health-related behavior influenced by physical and psychosocial factors[1]. Within the behavioral change models, self-efficacy is hypothesized to increase as an individual progresses to more advanced stages of readiness for change[2]. Aim of the study is to investigate the association between RTW self-efficacy and the stages of readiness in a cohort of injured workers with work-related musculoskeletal conditions.

### Methods:

A total of 632 claimants completed the baseline telephone interview at one-month follow-up and 446 claimants could be reached for six-month follow-up. Return-to-Work Self-Efficacy (RTWSE) was measured with a 10-item questionnaire based on a scale of Shaw [1]. Using factor analysis, three subscales were derived: RTWSE with regard to 1.Controlling pain at work; 2.Obtaining help from supervisor and 3.Obtaining help from co-workers. Stages of change were assessed with the validated Readiness for Return-To-Work (RRTW) Scale, reflecting closely the five stages described in the Readiness for RTW model[1,3]: Precontemplation, Contemplation, Prepared for action in the not-working individuals and Uncertain Maintenance and Proactive Maintenance in the working individuals. ANOVA tests were conducted to compare relationships for each of the three RTWSE subscales with the stages of change on the RRTW scale.

### Results:

All analyses were significant at both time measures, except for the co-worker RTWSE subscale at one-month follow-up. At both time measures, the mean scores of the RTWSE subscales increased over more advanced stages of change, however, it significantly decreased when comparing the mean scores of the Prepared for action behavioral phase and the Uncertain maintenance phase on all three subscales of RTWSE at both time measures.

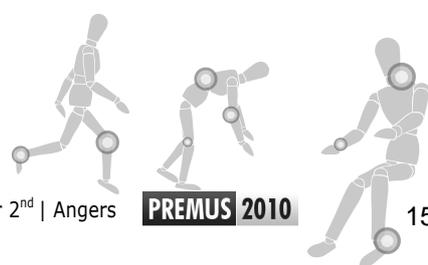
### Conclusion:

The hypothesis that less advanced stages of change on the RRTW scale would be associated with lower RTWSE could not be completely confirmed. In the stages in which workers report proactive and positive strategies to return to work, RTWSE was higher than the other stages for all subscales at both times. However, RTWSE decreases significantly for people who start working again (Uncertain Maintenance phase). These workers might experience discouragement and uncertainty about the likelihood of being able to remain back at work. These findings point to the importance of incorporating RRTW strategies in those workers who return to work, i.e. to enhance self-efficacy beliefs in the uncertain maintenance phase.

**Keywords:** Psychosocial factors, Return to work, Pain, chronic pain.

### References:

1. Shaw WS, Huang YH. Concerns and expectations about returning to work with low back pain: Identifying themes from focus groups and semi-structured interviews. *Disabil Rehabil.* 2005;27:1269-1281.
2. Franche R-L, Krause N. Readiness for return to work following injury or illness: Conceptualizing the interpersonal impact of health care, workplace, and insurance factors. *J Occup Rehabil.* 2002; 12: 233-256
3. Franche R-L, Corbière M, Lee H, Breslin FC, Hepburn CG. The Readiness for Return-To-Work (RRTW) scale: Development and Validation of a Self-report Staging Scale in Lost-time Claimants with Musculoskeletal Disorders. *J Occup Rehabil.* 2007;17:450-472



## THE ROLE OF ORGANIZATIONAL POLICIES AND PRACTICES IN EFFECTING SELF-EFFICACY IN RETURN TO WORK FOLLOWING CARPAL TUNNEL SURGERY

AMICK B.C., IHA S., KATZ J.

*Institute for Work & Health, Toronto, Canada.*

### **Aims:**

While numerous studies have reported the role of self-efficacy in return to work, little research has considered the determinants of self-efficacy and changes in self-efficacy. We examine the role of organizational policies and practices (OPPs) in changing self-efficacy.

### **Methods:**

Data from an observational cohort study that examined the multi-dimensional predictors of return to work in 130 workers considered how self-efficacy changed following surgery and the role of organizational policies and practices (people-oriented culture, safety practices, disability management, ergonomic policies and practices). Baseline measures one month prior to surgery were followed up by measures at 2, 6 and 12 months post-surgery. Self-efficacy was measured with 4 items assessing confidence in the person's ability to manage pain and the return to work process. A change in self-efficacy was constructed by subtracting the baseline from the follow-up scale score. OPPs were measured as an overall supportive organizational climate ( $\alpha=.88$ ). Multiple regression models were used to test hypotheses. All models were adjusted for baseline self-efficacy.

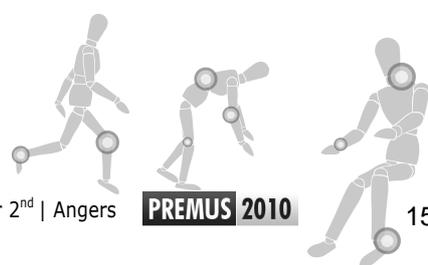
### **Results:**

OPPS were significant predictors of change in self-efficacy at 2, 6 and 12 months post-surgery after adjustment for multiple covariates. At two and six months the most important predictors were ergonomic policies and practices and disability management, while at 12 months the most significant predictors were people-oriented culture and safety practices. Job accommodation was not a significant predictor.

### **Conclusion:**

These results show the importance of the policies and practices that organizations implement as key predictors of a workers self-efficacy in RTW. The results suggest that interventions should target changes policies and practices in addition to the clinical management of return to work.

**Keywords:** Early prevention, Disability prevention, Carpal tunnel syndrome.



## THE WORKSITE AS ARENA FOR HEALTH ENHANCING INTERVENTIONS. LESSONS LEARNT FROM RECENT AND CURRENT RCT STUDIES

### **Symposium Description**

Symposium under the PREMUS topic: Intervention, primary prevention, work organization

Outline:

Prevention of work related diseases, such as musculoskeletal disorders, include implementation of PA. Recently manifold initiatives have been taken and this symposium will highlight the state of the art regarding health promotion activities at the worksite. Focus will be on RCT studies and health outcomes in terms of musculoskeletal disorders such as low back and neck/shoulder pain but also include general fitness, cardiovascular diseases, and overweight that may affect musculoskeletal health.

Program:

Integrated health programme: a work place randomized controlled trial

*Torill Helene Tveito, PhD, Faculty of Psychology, University of Bergen, Norway*

Telemedicine applications offering treatment in home/work situation for neck/shoulder symptom intensity and disability

*Miriam Vollenbroek-Hutten, Professor, Roessingh Res & Dev, Enschede, Netherlands*

Interventions aiming at preserved work ability among employees in job groups with high physical demands, FINALE.

*Karen Sjøgaard, Professor, University of Southern Denmark, Odense, Denmark*

A research-to-practice effort examining the effectiveness of worksite programs integrating workplace health promotion and occupational ergonomics. CPH-NEW

*Laura Punnett, Professor, Department of Work Environment, University of Massachusetts, USA*

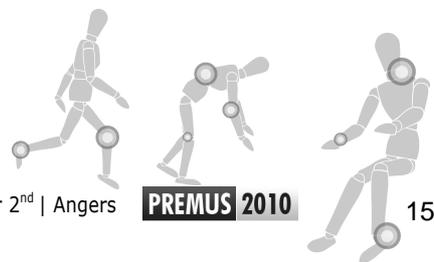
### **Symposium Author**

MD,PhD Gisela SJØGAARD

Karen SØGAARD

### **Authors linked to the symposium**

<b>Authors linked to the symposium</b>	<b>Name of their abstract</b>
TVEITO T.H.	Integrated health programme: a workplace randomized controlled trial
VOLLENBROEK-HUTTEN M.	Telemedicine applications offering treatment in home/work situation for people with musculoskeletal pain
SØGAARD K.	Interventions aiming at preserved work ability among employees in job groups with high physical demands, FINALE
PUNNETT L.	Musculoskeletal disorders and work organization: advantages and limitations of workplace RCTs vs. other study designs for research-to-practice



## INTEGRATED HEALTH PROGRAMME: A WORKPLACE RANDOMIZED CONTROLLED TRIAL

TVEITO T.H., ERIKSEN H.R.

Harvard School of Public Health, USA.

### Aims:

Nursing personnel is considered a high risk group for musculoskeletal complaints. Musculoskeletal complaints are a major cause of sick leave and thus of considerable economic consequences to companies and the society. Musculoskeletal complaints were related to low health related quality of life in the baseline screening of the nursing population in this study. Physical exercise has been shown to reduce musculoskeletal symptoms and the risk of sick leave in nursing personnel. The aims of this study were to assess if an intervention consisting of physical exercise, health information, and stress management training would succeed in reducing sick leave and level of subjective health complaints in employees in a nursing home for the elderly.

### Methods:

After a baseline screening the employees who had agreed to participate (n = 40) were randomised to an intervention and a control group. The intervention group was allowed by the employer to participate in an "Integrated Health Programme" during working hours twice weekly for 9 months. Each session lasted 1 hour. The "Integrated Health Programme" consisted of physical exercise, stress management training, health information, and one visit at the actual work place of the participants. The control group was offered the same intervention after the project was finished. Data on sick leave, subjective health complaints, coping, health related quality of life (SF36), and psychological work variables were collected.

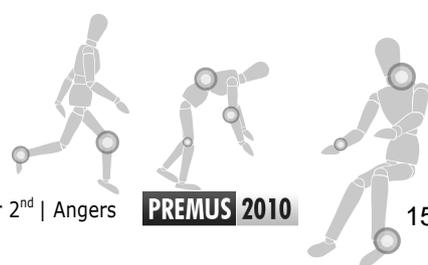
### Results:

There were no significant effects on sick leave or health related quality of life. The intervention group reported less neck complaints compared to the control group, otherwise there were no effects on subjective health complaints. But the subjective effects were large and highly significant, the intervention group reported improvement in health, physical fitness, muscle pain, stress management, maintenance of health, and work situation.

### Conclusion:

The "Integrated Health Programme" was not effective in reducing sick leave and subjective health complaints. The intervention group reported less neck complaints, but no effect on other musculoskeletal complaints. However, the intervention may have increased job satisfaction among the employees and may be useful for employers aiming to increase employee health and wellness.

**Keywords:** Health care workers, Intervention studies, Disability prevention.



## TELEMEDICINE APPLICATIONS OFFERING TREATMENT IN HOME/WORK SITUATION FOR PEOPLE WITH MUSCULOSKELETAL PAIN

VOLLENBROEK-HUTTEN M.M.R.<sup>1,2</sup>, HERMENS H.J.<sup>1,2</sup>, HUIS IN 'T VELD M.H.A.<sup>1</sup>, VAN WEERING M.<sup>1</sup>

<sup>1</sup> Roessingh Research and Development, Enschede, The Netherlands – <sup>2</sup> University of Twente, Enschede, The Netherlands.

### Aims:

There are high expectations of Information and Communication Technology to make health care more cost-effective. As a result a lot of initiatives are being developed but 75% of them fail. This brings the question: how to create telemedicine applications that can be successfully implemented. This paper describes a method consisting of three elements for telemedicine applications and illustrates this method for two applications for musculoskeletal pain.

### Methods:

The three aspects of the method are

1. Clinical content. As telemedicine applications aim at supporting subjects with complaints in their self management, applications need to quantitatively monitor a subjects functioning and to give adequate feedback to enable the subject to change.
2. Design; Applications need to be designed in a way they will be accepted by end users
3. Outcome: The applications need to have positive effects in terms of effectiveness and efficiency.

### Results:

Clinical Content: Experimental studies have shown that subjects with chronic pain show a decreased ability to relax muscles (van der Hulst et al, 2009) and a deviating general activity pattern over the day (van Weering et al, 2009). As subjects are often not aware of this, feedback during every day life tasks is considered useful.

Design: Two different applications, MyoTel (focusing on muscle activation patterns) and ACTTEL (focusing on activity patterns) were developed. In both applications, functioning is measured in an unobtrusive ambulant manner using a sensor system that is connected to a PDA. The PDA provides feedback to the subject and transfers subject data wirelessly to a secured server, remotely accessible for the therapist. The therapist supervises the subjects during treatment that starts and ends with a face to face visit with in between e-consultations.

Outcome: The Staged Approach of DeChant (1996) is used, starting with small uncontrolled studies for first prototypes and switching to larger clinical trials for mature applications. A prognostic study for ACCTEL in 15 subjects with chronic low back pain showed that pain intensity decreased significantly ( $p=.000$ ) and that subjects are able to better balance their activity patterns. An RCT ( $n=138$ ) for the MyoTel intervention showed that Myotel is as effective as usual care both on pain and disability and that the time investment of the professionals reduces with 20%.

### Conclusion:

In conclusion, telemedicine services as the MyoTel and ACTTEL are of high potential for our health care for patients with musculoskeletal pain both in terms of effectiveness and efficiency

**Keywords:** Muscle activity, Intervention methods, Pain, chronic pain.

### References:

- Hulst M van der, Vollenbroek-Hutten MM, Rietman JS, Hermens HJ. J Electromyogr Kinesiol, 2009a; 13. [Epub ahead of print]  
Weering MG van, Vollenbroek-Hutten MM, Tönis TM, Hermens HJ. Eur J Pain. 2009;13(6): 649-54  
DeChant HK, Tohme WG, Mun SK, Hayes WS, Schulman KA. Telemed J, 1996; 2: 303-12



## INTERVENTIONS AIMING AT PRESERVED WORK ABILITY AMONG EMPLOYEES IN JOB GROUPS WITH HIGH PHYSICAL DEMANDS, FINALE

SØGAARD K., JØRGENSEN M.B., GRAM B., CHRISTENSEN J.R., FABER A., OVERGAARD K., EKTOR-ANDERSEN J., MORTENSEN O.S., SJØGAARD G., HOLTERMANN A.

*Institute of sport science and clinical biomechanics, University of Southern Denmark, Odense, Denmark*

### Aims:

A mismatch between individual physical capacities and physical work demands enhance the risk for musculoskeletal disorders, poor work ability and sickness absence, termed physical deterioration. However, effective intervention strategies for preventing physical deterioration in job groups with high physical demands remains to be established. This presentation describes the background, design and conceptual model of the FINALE programme, a framework for health promoting interventions at 4 Danish job groups (i.e. cleaners, health-care workers, construction workers and industrial workers) characterized by high physical work demands, musculoskeletal disorders, poor work ability and sickness absence.

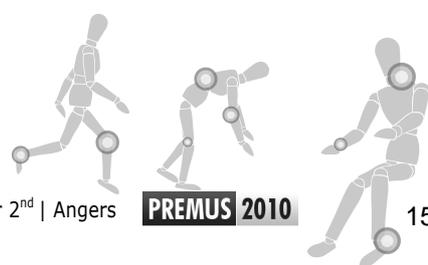
### Methods:

A novel approach of the FINALE programme is that the interventions, i.e. 3 randomized controlled trials (RCT) and 1 exploratory case-control study are tailored to the physical work demands, physical capacities and health profile of workers in each job-group. The RCT among cleaners, characterized by repetitive work tasks and musculoskeletal disorders, aims at making the cleaners less susceptible to musculoskeletal disorders by physical coordination training or cognitive behavioural theory based training (CBTr). Because health-care workers are reported to have high prevalence of overweight and heavy lifts, the aim of the RCT is long-term weight-loss by combined physical exercise training, CBTr and diet. Construction work, characterized by heavy lifting, pushing and pulling, the RCT aims at improving physical capacity and promoting musculoskeletal and cardiovascular health. At the industrial work-place characterized by repetitive work task, the intervention aims at reducing physical exertion and musculoskeletal disorders by combined physical exercise training, CBTr and participatory ergonomics. The overall aim of the FINALE programme is to improve the safety margin between individual resources (i.e. physical capacities and cognitive skills) and physical work demands, and thereby reduce the physical deterioration in a long term perspective by interventions tailored for each respective intervention.

### Conclusion:

The FINALE programme has the potential to provide evidence-based knowledge of significant importance for public health policy and health promotion strategies for employees at high risk for musculoskeletal disorders and physical deterioration.

**Keywords:** Personal risk factors for MSD, Intervention studies, Disability prevention.



## MUSCULOSKELETAL DISORDERS AND WORK ORGANIZATION: ADVANTAGES AND LIMITATIONS OF WORKPLACE RCTS VS. OTHER STUDY DESIGNS FOR RESEARCH-TO-PRACTICE

PUNNETT L., CHERNIACK M., CPH-NEW RESEARCH TEAM.

*Dept. of Work Environment, Univ. of Massachusetts Lowell, Lowell MASSACHUSETTS, USA*

### Aims:

Randomized clinical trials (RCTs) have clear advantages in the control of confounding and are usually considered the “gold standard” for validity. However, other occupational intervention study issues are not necessarily resolved with a RCT design, including exposure targets (especially group-level organizational features) for which randomization and blinding are not feasible, and the exclusion of participatory processes which may be essential for effective changes in work organization. These issues are particularly salient for psychosocial exposures (relevant for primary or secondary prevention of work-related musculoskeletal disorders (MSDs)) and for worksite health-promotion programs, which typically have unequal effectiveness in engaging workers from all socioeconomic levels. Mixed methods, including observational studies and qualitative process evaluations, can enhance understanding of workers’ health needs and of why scientific knowledge does not always lead to improved worksite practices.

### Methods:

The Center for the Promotion of Health in the New England Workplace (CPH-NEW) is an interdisciplinary research-to-practice effort examining the effectiveness of integrating disease prevention and exposure reduction at the workplace with health promotion (HP) at the group and individual level, emphasizing musculoskeletal health. One fixed cohort study, in the nursing home sector, evaluates a corporate Safe Resident Handling program, with or without concurrent “top-down” or participatory WHP. In public corrections facilities, a similar study compares best professional practices with participatory ergonomics and WHP programs. Initial focus groups provided needs assessments and an avenue for recruiting workers into participatory activities.

### Results:

Nursing home workers’ baseline health behaviors (lack of exercise, obesity, smoking) were associated with a range of psychosocial factors: low decision latitude and social support, regular night shift work, recent assault, etc. Two years after implement of the ergonomics program, nursing assistants had lower ergonomic exposures related to manual resident handling and lower compensation claims for back and other MSDs. However, centers with corporate HP promotion activities were no different from control centers in worker obesity, inactivity, smoking, or other health indicators. The participatory health teams in both sectors are actively addressing organizational factors such as communications and problem-solving.

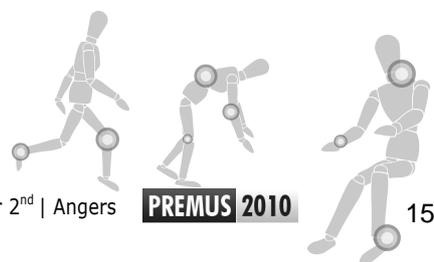
### Conclusion:

The worksite may be an arena for health-enhancing interventions but it may also present obstacles to healthy behaviors, beyond the recognized health and safety hazards. Occupational health promotion interventions should address the full range of relevant risk factors - work organization, physical ergonomics, and root causes of psychosocial strain – not only individual capacities and behaviors.

**Keywords:** Work organization, Early prevention, Intervention studies.

### Reference:

Punnett L, Cherniack M, Henning R, et al. A conceptual framework for the integration of workplace health promotion and occupational ergonomics programs. *Public Health Reports* 2009; 124 (Suppl 1): 16-25.



## EARLY PREVENTION, WORK ORGANISATION AND PARTICIPATIVE APPROACHES

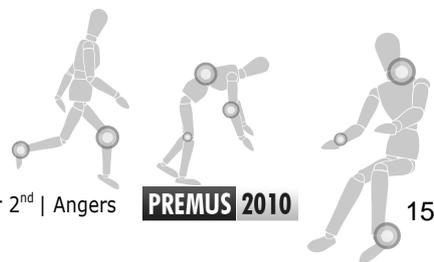
### **Symposium Chairs**

David REMPEL

Agnès AUBLET-CUVELIER

### **Authors linked to the symposium**

<b>Authors linked to the symposium</b>	<b>Name of their abstract</b>
OUELLET S.	Ergonomic intervention research for MSD prevention: blending of two action frameworks towards a common goal
DRIESSEN M.T.	The effectiveness of participatory ergonomics to reduce psychosocial and physical risk factors for low back pain and neck pain; results of a cluster randomised trial
DUGUE B.	WMSD prevention: assessment of an ergonomic intervention six years later
BUCHMANN W.	Which possibilities for sustainable prevention of WMSD within lean manufacturing production methods?
KRAMER D.M.	Encouraging the adoption of ergonomic innovations: examining the effect of knowledge transfer techniques on construction companies' decisions to adopt innovations to reduce the risk of musculoskeletal disorders (MSD)



## ERGONOMIC INTERVENTION RESEARCH FOR MSD PREVENTION: BLENDING OF TWO ACTION FRAMEWORKS TOWARDS A COMMON GOAL

OUELLET S., VÉZINA N.

CINBIOSE, Université du Québec à Montréal, Montréal, Canada

### Aims:

In ergonomics, the intervention can be an integral part of the research (Teiger, 2007). The presented study was carried out in the meat processing sector with the dual objective of generating new knowledge about job training for MSD prevention and of responding to the request of a company that wanted training content as well as guidance in the organization of its training (Ouellet, 2009). This paper describes the interrelationship of the methodological aspects developed and their complementarity.

### Methods:

The developed methodology combines the production of knowledge in cooperation with the stakeholders and concrete action proposals (Gillet, 2008). It has two phases: 1) description of the knowledge and know-how of experienced workers (N=6); and 2) daily follow-up, with audio recordings and interviews, of the training given to three groups of apprentices (N=7). Each follow-up led to the analysis of knowledge transmission, training organization, learning conditions and the evolution of the apprentices' symptoms and difficulties. After each training of a group, recommendations were given to improve the next group's learning conditions. The researcher ergonomist followed up on the implementation of the recommendations and his support was necessary to ensure their implementation for group 3's training.

### Results:

Several results made it possible to answer research questions as well as respond to the company's request. For example: 1- analysis of the experienced workers' activity allowed the potentially transmissible knowledge to be put into words, knowledge that was used in analyzing the transmission during the training (research) and in constructing a training manual for the company; 2- the results relating to training organization, the learning conditions, the difficulties encountered and the pain felt, were used to choose the days of analysis for knowledge transmission (research) and to propose recommendations to the company. At every step in this intervention research, decisions had to be made in order to achieve the research objectives and the action objectives, such as whether the ergonomist would intervene or not during the training of group 3.

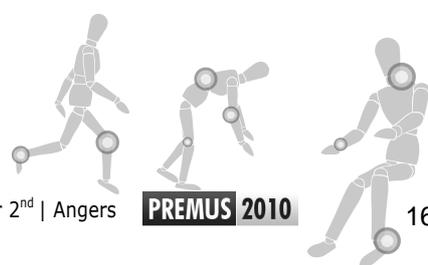
### Conclusion:

This study shows that the methodological aspects of intervention research are linked since they provide data that allow the generation of new knowledge and a response to a request from a workplace, thus promoting involvement of the stakeholders as well as actions for MSD prevention. However, this type of study may require constant adjustment during its execution.

**Keywords:** Work organization, Early prevention, Intervention studies

### References:

- Gillet A. La recherche en entreprise dans le cadre d'un doctorat; Un mariage entre recherche académique et utilité sociale. In: F., Pichault, et al. (coordinators). La recherche-intervention peut-elle être socialement responsable? Paris: Vuibert; 2008. p. 27-45.
- Ouellet S. Acquisition d'habiletés motrices à la découpe de viande et prévention des troubles musculo-squelettiques : apport de l'analyse ergonomique à la conception de formation. Département des Sciences biologiques, Université du Québec à Montréal, Doctoral thesis; 2009. 590 p. <http://www.archipel.uqam.ca/>
- Teiger C. De l'irruption de l'intervention dans la recherche en ergonomie. *Éducation permanente*. 2007;170:34-49.



## THE EFFECTIVENESS OF PARTICIPATORY ERGONOMICS TO REDUCE PSYCHOSOCIAL AND PHYSICAL RISK FACTORS FOR LOW BACK PAIN AND NECK PAIN; RESULTS OF A CLUSTER RANDOMISED TRIAL

DRIESSEN M.T., PROPER K.I., ANEMA J.R., KNOL D.L., BONGERS P.M., VAN DER BEEK A.J.

*Department of Public and Occupational Health & the EMGO Institute for Health and Care Research, VU University Medical Center, The Netherlands*

### Aims:

Low back pain (LBP) and neck pain (NP) are common among workers and have serious financial consequences for society and employers. Little is known about the effectiveness of participatory ergonomics (PE) to reduce work related risk factors for LBP and NP. Therefore, this study investigated the effectiveness of a PE programme to reduce psychosocial and physical risk factors.

### Methods:

In this cluster-RCT, 37 departments of four Dutch companies participated. In each company, departments with comparable work demands were matched into pairs and randomly allocated to either the intervention (PE) or control group (no PE). The computer generated randomisation procedure resulted in 19 intervention departments (n=1472 workers) and 18 control departments (n=1575 workers). PE is a stepwise approach in which working groups compose, prioritise, and implement ergonomic measures aimed at reducing the psychosocial and physical workload. Data on both the psychosocial and physical risk factors for LBP and NP were collected at baseline and after 6-months follow-up. Psychosocial risk factors were measured by means of the Job Content Questionnaire (JCQ). Seven JCQ dimensions were assessed: skill discretion, decision authority, decision latitude, psychosocial job demands, and supervisor, co-worker and social support. Eleven physical risk factors were measured by the Dutch Musculoskeletal Questionnaire (DMQ). Intervention effects were analysed by using multilevel analysis.

### Results:

After 6 months, workers in the intervention group significantly increased on decision latitude (0.29 points; 95% CI 0.07 - 0.52) in comparison to workers in the control group. Moreover, carrying heavy loads was significantly reduced in the intervention group (OR 0.52; 95% CI 0.27 - 1.01) compared to the control group. However, workers in the intervention group significantly increased in working in awkward positions (OR 1.86; 95% CI 1.15 - 3.01). No significant differences between both groups were found on the remaining risk factors.

### Conclusion:

Overall, after 6 months, PE was not effective to reduce psychosocial and physical risk factors among a heterogeneous group of workers after compared to the control group (no PE). These findings do not support the use of PE to reduce psychosocial and physical workload among workers.

**Keywords:** Intervention studies, Back, low back, Neck



## WMSD PREVENTION: ASSESSMENT OF AN ERGONOMIC INTERVENTION SIX YEARS LATER

DUGUE B., CHASSAING K., COUTAREL F.

*Ergonomics Department, Ecole Nationale Supérieure de Cognitique - IPB, Bordeaux, France*

### Aims:

In 2004, we presented the progress and results of an ergonomic intervention aiming at prevention of WMSD in a duck slaughterhouse (1). The focus was the design of a new carving line, from the beginning of the project, to a follow-up after start-up of the new system. The scope of the intervention included material devices, organizational aspects (division of tasks and work organization), and human resource management (training). We had highlighted the importance of room for manoeuvre, both from a physical and an organizational point of view, for the operators and for the management, as a key factor allowing activity adjustment and WMSD prevention.

### Methods:

Recently, the company asked for an assessment of the evolution of the implemented components and of their contribution to MSD prevention. We have carried out observations for 4 days in order to compare the present situation with the one we left 6 years ago. Interviews have been carried out with 8 line workers (senior and new), 3 shop floor managers, the production and the plant leaders. Data about production, personnel management and occupational health have been processed.

### Results:

Two years after our intervention, the company went through a difficult economic period, which led the top management to dismantle the choices made during the project in terms of work pace, production organization, and personnel management. In the following months, workers' complaints increased, occupational diseases were declared, and turnover reached a level similar to the one that existed before the intervention. After this period, when the management gained new room for manoeuvre, they came back to the organization we had proposed, dividing the production between two lines, decreasing the work pace and giving back room for manoeuvre to the workers for adjusting their work activity. The participatory approach we had used was also introduced again in the new investment projects. The company's production and health indicators started to improve again.

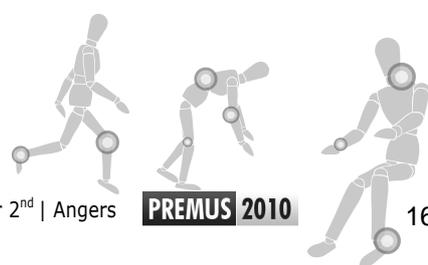
### Conclusion:

We can emphasize the transfer of knowledge and the development of skills allowed by the ergonomic intervention, including an understanding of WMSD aetiology, an acknowledgment of the importance of room for manoeuvre for the workers and the management, a participatory approach to projects, prevention actions in connection with the occupational medicine service. The plant management's stability during this period turned out to be a key factor fostering the return to a more protective and efficient work organization after the crisis.

**Keywords:** Work organization, Early prevention, Intervention studies.

### Reference:

Coutarel F, Daniellou F, Dugué B. Participatory design project management: addressing production effectiveness for WMSD prevention, the case of the carving line of a duck slaughterhouse. Zurich: Premus; 2004.



## WHICH POSSIBILITIES FOR SUSTAINABLE PREVENTION OF WMSD WITHIN LEAN MANUFACTURING PRODUCTION METHODS?

BUCHMANN W.<sup>1</sup>, BELLIES L.<sup>2</sup>, VOLKOFF S.<sup>1</sup>

<sup>1</sup> CREAPT, Noisy Le Grand, France - <sup>2</sup>. Eurocopter, Marignane, France.

### Aims:

Toulouse (2005) or Daniellou (2008) note the importance for ergonomists to find their place in Lean Manufacturing production methods. In a large company in the aircraft building sector, the aim of this study was to identify the possible cooperation between Safety and Health at Work (SHW) Teams and Lean Manufacturing projects Teams.

### Methods:

We participated, with a reflective practitioner point of view, in a Kaizen project. This project took place on a workstation neighboring and similar to another which had been analyzed by an ergonomist a few weeks before, and on which operators declared upper limbs musculoskeletal pains.

### Results:

The reflective participation to a workstation analysis with the Kaizen method reveals that Kaizen method, as conducted, presents positive aspects for SHW:

- Workstation is modernised (replacement of old tools, storage, cleaning station)
- People who implement the Kaizen projects are company employee: we can imagine that people build themselves an experience in Kaizen projects in adequacy with specific needs of the site work activity.

The analysis of this Kaizen project also reveals several expedients likely to affect the operators HSW:

- Workstation analysis is only performed during one working cycle (the working cycle is 2 days). Hence, industrial variability is insufficiently taken into account (whereas we observed variability during the similar and parallel work situation analysis: related tasks occasionally performed, workshop temperature on Monday morning during winter inadequate to implement the components in a proper way...),
- the "human at work capacities" point of view is rarely questioned,
- the work station Kaizen team analysis are based on an expedient work activity : work station cleaned before analysis, all components available, all operators present, all tools ready for use, up to 10 observers around work station...

### Conclusion:

Literature relates that production methods linked to Lean Manufacturing could generate bad consequences at more or less long term on workers SHW. In order to provide a sustainable prevention of the WMSDs (Caroly, 2008), the analysis of this Kaizen project revealed potential possibilities for SHW teams, especially during these steps:

- definition of the project objectives
- working standards draftings
- the solutions research and validation

We hope that this research (in progress) will provide tools to help SHW teams to cooperate with Lean Manufacturing projects Teams.

**Keywords:** Work organization, Early prevention, Intervention methods.

### References:

- Caroly, S., Coutarel, F., Escriva, E., Roquelaure, Y., Schweitzer, J.M. (2007). La prévention durable des TMS. Quels freins? Quels leviers d'action? Rapport DGT de la recherche-action 2004-2007.
- Daniellou, F. (2008). Développement des TMS : désordre dans les organisations et fictions managériales. Communication présentée au 2nd congrès francophone sur les TMS, Montréal, Canada, Juin.Toulouse 2005
- Toulouse, G., Nastasia, Imbeau, D., (2005). Etude de faisabilité en vue d'intégrer la santé et la sécurité du travail et l'ergonomie à l'approche PVA-Kaizen. Rapport de recherche IRSST R-428, Montréal, IRSST, 2005, 90 pages. [www.irsst.qc](http://www.irsst.qc)



## ENCOURAGING THE ADOPTION OF ERGONOMIC INNOVATIONS: EXAMINING THE EFFECT OF KNOWLEDGE TRANSFER TECHNIQUES ON CONSTRUCTION COMPANIES' DECISIONS TO ADOPT INNOVATIONS TO REDUCE THE RISK OF MUSCULOSKELETAL DISORDERS (MSD)

KRAMER D.M., CARLAN N., WELLS R., BIGELOW P., VI P., GARRITANO E.

*University of Waterloo, Ontario, Canada*

### **Aims:**

A collaborative study with researchers and stakeholders from the Ontario Infrastructure Health and Safety Association has identified new innovative tools, ideas and processes that can potentially reduce the risk of MSD. The innovations are being used by construction firms and were found on-site. Our goal is to evaluate the effectiveness of our different knowledge transfer techniques in encouraging the adoption of innovations.

### **Methods:**

We are following a conceptual framework of research implementation (the PARIHS model), which maps the relationship between the strength of the evidence, the characteristics of the context, and the success of the facilitation strategy.

To identify the innovations (the "evidence"), we conducted a conference with health and safety consultants, consulted with construction experts, and observed innovations during site visits. These innovations have been evaluated for their potential to reduce the risk of MSD, and their potential to improve productivity, quality, and costs over traditional work practices.

In our context analysis, we have made a comparison among the construction, manufacturing and the health-care sectors with respect to organizational context.

### **Results:**

After one year of on-site observations, the research team has found and evaluated 14 tools, one process (participative ergonomics), and two poster ideas (for example, "Help your back; keep stuff from the floor!"). After interviewing many construction firm managers, we have found that for wider acceptance of innovative ideas, the new innovations have to reduce the risk of MSDs and also improve productivity, quality, or materials management.

We have found that construction differs because of its constant changing work environment, labour-management structure, and diffuse decision-making process. We have identified strong networks in the construction sector such as labour-management safety associations, trade associations, union and educational networks, which can have the potential to facilitate the dissemination of the innovations.

We will be using numerous knowledge transfer approaches ("facilitation"), which include communicating the ideas to companies using association networks, offering the assistance of an ergonomist to the companies, providing access to innovations for trial periods, conducting tailgate meetings, conducting focus groups, and conducting conference sessions.

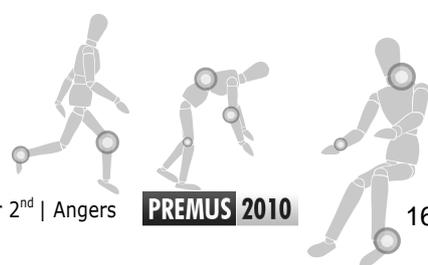
### **Conclusion:**

The collaborative relationship, the joint decision-making and the negotiated knowledge created by the researchers and the safety-association partners has been invaluable. The relationship has helped the researchers gain access to companies and networks, ensured the relevance of the research objectives, and has lent the project credibility with construction workers and firms.

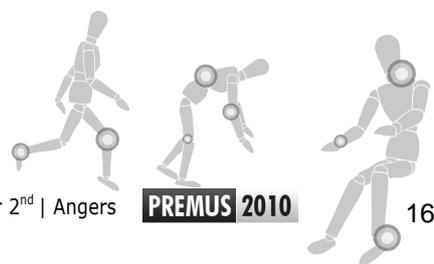
**Keywords:** Construction, Intervention studies, Other.

### **Reference:**

Kitson A, Rycroft-Molone J, Harvey G, McCormack B, Seers K, and Titchen A., 2008. Evaluating the successful implementation of evidence into practice using the PARIHS framework: theoretical and practical challenges. *Implementation Science*. 2008;3:1-12



# OPEN SESSIONS



## BIOLOGY AND MECHANISMS

### BACK MUSCLE INJURY: A CUMULATIVE TRAUMA PATHWAY

FALLETIN N.

*Liberty Mutual Research Institute for Safety, Hopkinton, USA*

#### Aims:

In the classical overexertion injury scenario a single event imposes a compressive force of the low back exceeding the tolerance of the vertebral end plate. However, this kind of back injury is rare, and in most cases a cumulative trauma pathway has created the prerequisite for the culminating event that leads to the injury. A central component in the cumulative trauma pathway is a fatigue induced lowering of the tissue tolerance over time (McGill, 1997). The underlying mechanism behind a fatigue induced reduction in tissue tolerance is poorly understood, but a number of theoretical explanations have been suggested.

#### Methods:

One approach focuses on tissue cell damage caused by a sustained contraction and the associated blood flow and oxygen restriction. In this metabolic model a disturbance in the milieu interne of the muscles renders the cells prone to overexertion damage and subsequent pro-inflammatory processes. A more complex neuromuscular model has however been introduced highlighting fatigue effects on the neuromuscular control of spinal stability. The emphasis on spinal stability is not surprising. An unstable spine can be damaged at compressive forces as low as 90 N while a stable spine, protected by active muscles, may be able to tolerate extreme compressive forces up to 18,000 N (Cholewicki et al., 1991). It is thus clear that any fatigue induced deterioration of the stability of the spine would have pronounced influence on the injury tolerance of the spine and the risk of low back injury. The ability of the muscular system to control spinal stability is to a large extent based on feedback provided from the paraspinal muscles. Proprioceptive information from muscle spindles is essential to maintain an adequate timing and magnitude of muscle contraction that can efficiently protect the spine and ensure that kinematic disturbances can be controlled and attenuated. In the fatigued muscle the quality of this proprioceptive information may be seriously hampered.

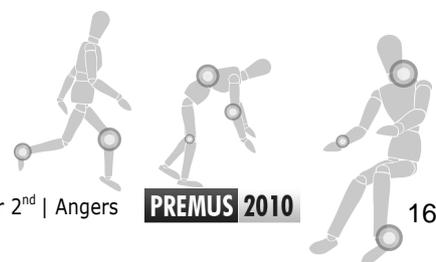
#### Results:

In this presentation an integrated model for loss of neuromuscular control of spinal stability is suggested. In this model, the metabolic disturbance has the potential to induce muscle damage either by directly affecting individual muscle cells or by affecting the muscle spindle system and thus initiating events leading to spinal instability and increased injury risk. The integrated model is an elaboration of the so called Brussels model for work related musculoskeletal disorders (Johansson et al., 2003) incorporating the specific feature of spinal stability.

**Keywords:** Mechanism of pain and tissue injury, Vulnerable workers, Back, Low back

#### References:

- Cholewicki J, McGill SM, Norman RW. Lumbar spine loads during lifting extremely heavy weights. *Med Sci Sports Exercise* 1991;23(10):1179-86.
- Johansson H, Arendt-Nielsen L, Bergenheim M, Blair S, van Dieen J, Djubsjöbacka M, Fallentin N et al. Epilogue: An integrated model for chronic work related myalgia "Brussels Model". In: Johansson H, Windhorst U, Djubsjöbacka M, Passatore M, editors. *Chronic work-related myalgia*. Gävle (Sweden): Gävle University Press; 2003.p 291-300.
- McGill SM. The biomechanics of low back injury: implications on current practice in industry and the clinic. *J Biomechanics* 1997; 30(5): 465-75.



## CONSERVATIVE SECONDARY INTERVENTIONS ARE EFFECTIVE AT ATTENUATING PERIPHERAL NERVE INFLAMMATION AND CONDUCTION VELOCITY DECLINES BUT NOT SENSORIMOTOR DECLINES WITH HIGH REPETITION HIGH FORCE TASK

BARBE M.F., ELLIOTT M.B., CLARK B.D., BARR A.E.

Temple University, Philadelphia, USA

### Aims:

We have shown that performance of high repetition tasks with or without force results in peripheral nerve inflammation and decreased conduction velocity (NCV), increased spinal cord neuropeptides, and motor dysfunction. Our aim here was to examine the effectiveness of ibuprofen versus ergonomic task reduction, when provided in weeks 5-12 of task performance, in attenuating these changes.

### Methods:

Young adult female Sprague-Dawley rats (n=54) underwent initial training for 5 weeks, then performed a HRHF task of reaching and handle pulling (12 reaches/min; 60% maximum force) for 2 hrs/day, in four 30 min sessions, 3 d/wk, for 12 wks. Ibuprofen (45 mg/kg body wt in drinking water daily) was administered to 19 HRHF rats in weeks 5-12 (HRHF-IBU); 19 other HRHF rats were moved to a low repetition low force task (LRLF; 3 reaches/min; 15% force) in weeks 5-12 (ergonomic intervention; HRHF-ERG). Controls included normal controls (NC); food restricted NC; NC+IBU, trained controls (TC), TC+IBU, and LRLF rats (n=7-15/gp). Grip strength, palmar mechanical sensation (measured using calibrated von Frey filaments) and voluntary reach performance outcomes (reach rate and duration) were assessed weekly. NCV was tested in week 12 in the median nerve of subsets (n=6-11/gp). Following euthanasia with sodium pentobarbital, tissues were collected from all rats but those tested for NCV. The median nerve was analyzed for macrophages and pro-inflammatory cytokines; cervical spinal cord segments were analyzed for Substance P immunoreactive product, a neurotransmitter linked to nociception.

### Results:

By week 12, both interventions attenuated HRHF task-induced declines in NCV (22%), increased macrophages and cytokines in the median nerve, and palmar hyposensation. However, palmar hypersensation was present in the intervention groups at week 12, a finding present in untreated TC and untreated HRHF in weeks 3-9. Neither intervention attenuated HRHF task-induced declines in grip strength or mean reaches per day (reach rate x duration). Grip strength in 12-week LRLF was lower than in controls (albeit not significantly), but also not significantly different from treated or untreated 12-week HRHF (which were decreased from controls, p

### Conclusion:

Use of two conservative secondary interventions ameliorated nerve inflammation and NCV declines. However, they did not attenuate pain behaviors present before onset of treatment, or a central neurochemical response, which likely contributed to the pain.

**Keywords:** Mechanism of pain and tissue injury, Intervention studies, Carpal tunnel syndrome

### References:

- Clark BD, Al-Shatti TA, Barr AE, Amin M, Barbe MF. Performance of a high-repetition, high-force task induces carpal tunnel syndrome in rats. *J Orthop Sports Phys Ther.* 2004; 34: 244-253
- Elliott MB, Barr AE, Clark BD, Amin M, Amin S, Barbe MF. High force reaching task induces widespread inflammation, increased spinal cord neurochemicals and neuropathic pain. *Neuroscience.* 2009; 158(2):922-931.
- Fedorczyk JM, Barr AE, Rani S, Gao HG, Amin M, Amin S, Litvin J, Barbe MF. Exposure-dependent increases in IL-1beta, substance P, CTGF, and tendinosis in flexor digitorum tendons with upper extremity repetitive strain injury. *J Orthop Res.* 2010; 28:298-307.



## NECK PAIN AND POSTURAL STABILITY AMONG WORKERS WITH HIGH POSTURAL DEMANDS

JØRGENSEN M.B., SKOTTE J., HOLTERMANN A., SØGAARD K.

National Research Centre for the Working Environment, Copenhagen, Denmark

### Aims:

Several studies have reported altered motor control strategies among people with neck pain, and different physiological causes are suggested. Different test and analysis methods of postural stability tasks may reveal the physiological mechanisms for the reduced motor control among people with neck pain. Since both high neck pain prevalence and postural demands are seen among cleaners – investigation of postural stability in this job group is particularly relevant. The primary aim of this study was to investigate mechanisms behind differences in postural stability among people with and without neck pain.

### Methods:

Postural stability of 135 cleaners with neck pain and without neck pain (controls) was studied with a force platform. The cleaners were asked to stand for 30 s in Romberg position with eyes open, closed and in unilateral stance. The success rate for completion of the unilateral test was registered. The center of pressure was calculated and decomposed into a rambling and trembling component. Subsequently the confidence ellipse area (CEA) was calculated.

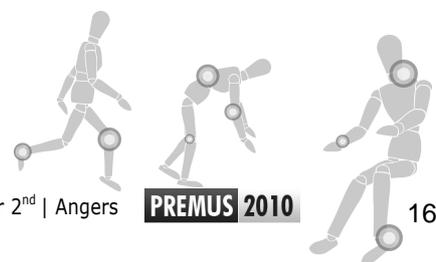
### Results:

Significantly more cleaners with neck pain fell during the unilateral stance compared with controls. Poorer postural control measured as CEA, rambling and trembling was observed among people with neck pain in comparison with controls in the Romberg with closed eyes, but not in Romberg with open eyes.

### Conclusion:

The high percentage of cleaners with neck pain not able to perform the functional unilateral stance without falling indicates that poor postural stability is closely related with neck pain in workers with high postural demands. The observed differences in both the CEA, and rambling and trembling between the cleaners with and without neck pain indicate that both peripheral and central mechanisms play a role in the neck-pain-related reductions of postural stability. These findings have clinical relevance for prevention and rehabilitation of neck pain among workers with high postural demands.

**Keywords:** Postures, physical exposure, Neck, Pain, chronic pain



## MUSCLE RECOVERY TIME FROM A SINGLE EXHAUSTIVE WORK BOUT IN THE HEAT

OKSA J., RISSANEN S., MÄKINEN T., TAKATALO K., LUSA S., LINDHOLM H., RINTAMÄKI H.

*Finnish Institute of Occupational Health, Finland*

### Aims:

Insufficient recovery time from work may lead to a state of cumulative muscle fatigue which may be regarded as a precursor for musculoskeletal symptoms and disorders (1). The purpose of this study was to evaluate the time needed for wrist flexor muscles to recover from a single heavy work bout in the heat.

### Methods:

Fifteen voluntary firefighters participated in the study. Their mean age ( $\pm$ SD) was  $35\pm 9$  yrs, height  $176\pm 6$  cm, weight  $83\pm 10$  kg and body mass index  $26.6\pm 2.5$  kg/m<sup>2</sup>. They performed a maximal 20 minute work bout at 35°C dressed in a fully encapsulating smoke diving suit and a self contained breathing apparatus (SCBA). Before the work the subjects were exposed to the same temperature for 20 minutes in a seated posture. The work bout simulated smoke diving and clearance work and was able to induce significant fatigue to the working wrist flexor muscles. It consisted of hammering a truck tire, rolling a hose, ascending and descending stairs, hose carrying and going under and above an obstacle

Before starting the work (baseline) and at each time point muscle tissue oxygen consumption with near infrared spectroscopy (NIRS, Oxymon MK III, Artinis Medical Systems, The Netherlands) and muscle structure (pennation angle) with ultrasound device (Logiq 5 Pro, GE Medical Systems, USA) were measured. Recovery from fatigue was followed at time points 0, 20, 40, 60 minutes and 2 and 4 hours after cessation of work.

### Results:

At baseline muscle oxygen consumption was  $12.9\pm 1.7$   $\mu$ M/min. Immediately after the work it increased to  $22.0\pm 2.2$   $\mu$ M/min ( $p<0.05$ ) and remained significantly elevated throughout the recovery period being at the 4 hour time point  $17.5\pm 1.6$   $\mu$ M/min ( $p<0.05$ ). Muscle pennation angle at baseline was  $15.7\pm 0.8^\circ$  and increased after the work to  $18.4\pm 0.8$  ( $p<0.05$ ). After two hours pennation angle was no longer significantly different from baseline value.

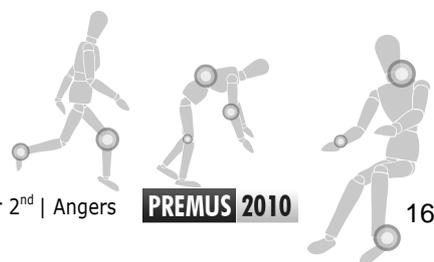
### Conclusion:

The results show that muscle oxygen consumption does not reach baseline level during the 4 hour recovery period. This indicates that removal of metabolic waste products and/or oxygen debt are still present in the local muscle tissue. Muscle structure recovered at time point 2 hours indicating that recovery time is different depending on the measured parameter.

**Keywords:** Muscle activity, Exposure measurement methods

### Reference:

Buckle P, Devereaux J. Work-related neck and upper limb musculoskeletal disorders. Report of European Agency for Safety and Health at Work. 1999. ISBN 92-828-8174-1.



## STRESS BIOMARKERS' ASSOCIATIONS TO PAIN IN THE NECK, SHOULDER AND BACK IN HEALTHY MEDIA WORKERS. 12-MONTH PROSPECTIVE FOLLOW-UP.

SCHELL E.<sup>1</sup>, THEORELL T.<sup>2</sup>, HASSON D.<sup>3,4</sup>, ARNETZ B.<sup>4,5</sup>, SARASTE H.<sup>1</sup>

*1 Karolinska Institutet, Department of Molecular Medicine and Surgery, Stockholm, Sweden - 2 Karolinska Institutet, National Institute for Psychosocial Factors and Health, and Center for Health Sciences, Stockholm, Sweden. - 3 Karolinska Institutet, CRU, Stockholm, Sweden - 4 Uppsala Universitet, Department of Public Health and Caring Sciences, Uppsala, Sweden - 5 Division of Occupational and Environmental Health, Department of Family Medicine and Public Health Sciences, Wayne State University, Detroit, Michigan, USA*

### Aims:

Physiological and psychological mechanisms have been proposed to link stress and musculoskeletal pain, and a number of stress biomarkers in patients with chronic pain have shown to be associated with stress-related disorders as well as health and recovery. The aim was to study if similar results might be found in a working population, in stress and computer intensive occupations with mild/moderate pain in neck, shoulder and back. The questions were if there are:

- associations between self rated neck, shoulder and back pain (VAS) on one hand and stress-related (catabolic), recovery related (anabolic) variables, cardiovascular/ lifestyle factors and immune markers on the other hand.
- associations between long term changes in pain and stress marker values (6 month period)
- predictive values in stress biomarkers for pain (12 month period)

### Methods:

A randomized study group with 121 media workers, 68 males (average 43 yrs) and 53 females (average 47 yrs), at news departments of a media company and a reference group at another news department in the same company with 106 media workers, 60 males (average 44 yrs) and 46 females (average 42 yrs) were recruited. Pain occurrence and pain level in neck, shoulder, upper and low back were self-rated at 3 times with a 6-month interval in both groups. The study group participated in stress biomarker sampling, at the same intervals, but not the reference group.

### Results:

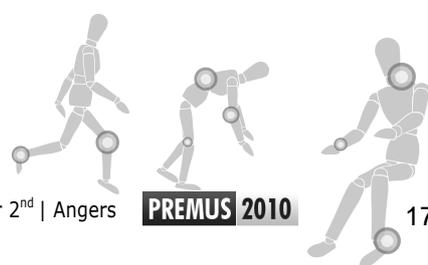
There were no differences in pain levels and occurrences of pain, medicine intake or computer working hours between the study and reference groups during the 12 month study period (rate of participation 99%).

- Cross-sectional analyses in the study group on differences in stress biomarkers in groups of “no pain” and “pain” showed less beneficial stress biomarker levels ( $p < 0.05$ ) in the “pain” group after age and gender adjustments in: S-DHEA-S and P-endothelin, S-insulin and P-fibrinogen. Analyses of each gender separately, adjusted for age, revealed in males differences in S-insulin, saliva cortisol 3, and P-endothelin. Furthermore, tendencies were seen in BMI, P-fibrinogen, and S-testosterone. In the female “pain” group a less beneficial P-BNP level was found.
- Longitudinal analysis of changes in pain levels and stress biomarkers within an interval of 6 months showed beneficial changes in the following stress markers: P-NPY, S-albumin, S-growth hormone and S-HDL when pain decreased, and vice versa when pain increased.
- Linear regression analyses showed statistically significant predicting values at the initial test instance for pain 12 months later in lower S-DHEA-S and S-albumin and higher B-HbA1c and P-fibrinogen. In stepwise regression and after age and gender adjustments, the associations with S-DHEA-S remained statistically significant.

### Conclusion:

The present study shows that individuals in working life with a high level of regenerative/anabolic activity are less likely to have pain than other subjects, and that decreased regenerative/anabolic activity is associated with increasing pain. The levels of NPY, albumin, GH and HDL increased when pain decreased and vice versa. Lower DHEA-S predicted pain 12 months later. Findings might have implications for preventing chronic pain in persons with early pain.

**Keywords:** Stress biomarkers, neck- shoulder- and back pain, work stress.



## BIOMECHANICS

### A STOCHASTIC 3D STATIC HAND FORCE PREDICTION MODEL FOR ESTIMATING MAXIMUM FEASIBLE HAND FORCES DURING UNILATERAL EXERTIONS

FISCHER S.L., DICKERSON C.R., WELLS R.

*Department of Kinesiology, University of Waterloo, Waterloo, Canada*

#### Aims:

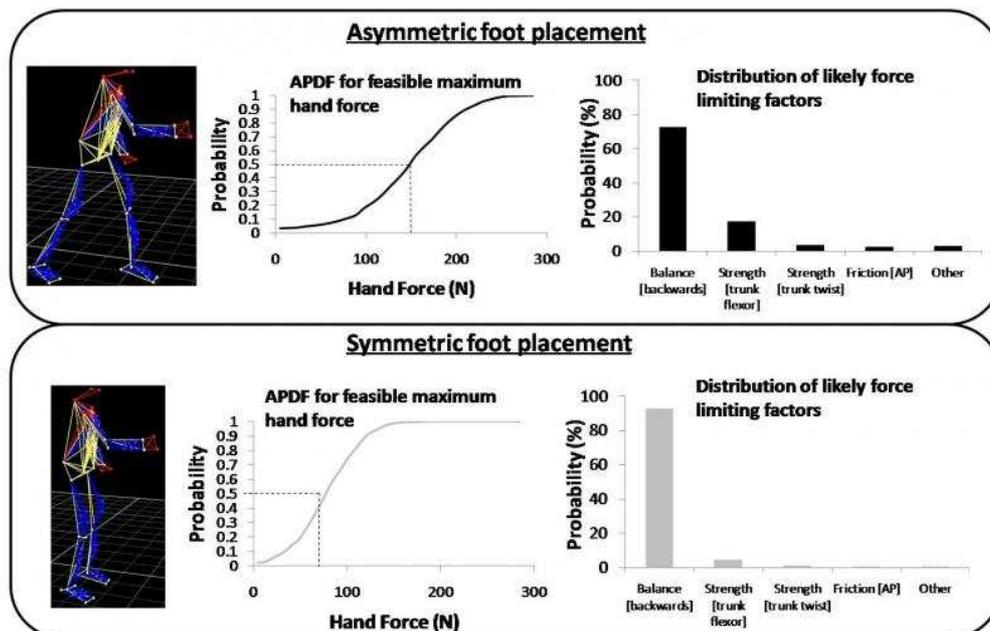
Estimating maximum feasible hand forces is advantageous for setting threshold values for exposure to forceful exertions in the workplace. Sub-maximal thresholds are then derivable based on the number of cycles performed in a shift and the task's duty cycle. A stochastic biomechanical model was developed to predict:

1. maximum feasible hand forces,
2. the biological constraint that likely limited an exertion (balance, individual joint strength, or friction),
3. expected variability in maximum feasible hand forces.

#### Methods:

The model consisted of a 3D static linked 17-segment model and a stochastic model to predict biological constraints. The linked segment model inputs included: gender, stature, weight, posture, and the applied hand force direction. Outputs included: individual joint moments, normal force, and the location of the ground reaction force. Outputs were calculated iteratively as hand force magnitude increased from 1N to 1000N in 1N increments. These outputs were passed into the stochastic constraint model to determine the maximum feasible hand force satisfying 26 stochastically generated inequality constraints [4 balance, 2 friction, and 20 strength]. Constraint threshold values that defined the inequalities were iteratively chosen from a normal distribution of feasible constraint thresholds based on published experimental results (i.e. Holbein, 1997). Monte-Carlo simulation was used (n=10000) to determine the range of maximum feasible hand forces.

#### Results:



**Figure 1:** Model predicted range of maximum feasible hand forces (expressed as an APDF) and the distribution of factors likely limiting force production during a unilateral forward push with asymmetric and symmetric foot placements.

#### Conclusion:

Predicted force limiting factors compared well with theoretical expectations. Figure 1 demonstrates how hand force is most likely limited by balance or trunk strength, depending on foot placements. The model predicted that this trade-off between balance and trunk strength shifts towards trunk strength as a more likely constraint, as the distance between the feet is increased. The model is currently undergoing evaluation to

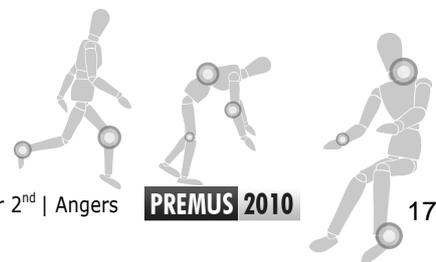


ensure that predicted hand force estimates agree with experimentally determined maximum producible hand forces during unilateral exertions.

**Keywords:** Biomechanics, Postures, physical exposure, Exposure measurement methods

**Reference:**

Holbein MA, Chaffin DB. Stability limits in extreme postures: Effects of load positioning, foot placement, and strength. *Human Factors*. 1997; 39:456-468.



## COMBINED HAND-ARM AND WHOLE-BODY VIBRATION EXPOSURE - THE EFFECT ON MUSCULAR ACTIVITY IN THE TRAPEZIUS

LEWIS C., BURSTRÖM L., SUNDELIN G.

*Department of Environmental and Occupational Health Sciences, School of Public Health, University of Washington, Seattle, USA*

### Aims:

Occupational drivers in general report a high prevalence of musculoskeletal disorders. In Sweden, 21.7% of occupational drivers reported work-related symptoms and 4.1% had been on sick leave pension for more than five weeks. Occupational drivers of terrain vehicles are exposed to several risk factors associated with musculoskeletal symptoms in the neck. Vibration has been suggested to be one risk factor. These drivers are exposed to both whole-body vibration (WBV) and hand-arm vibration (HAV). The aim of this study was to investigate the electromyographic (EMG) response in the neck in a combined HAV and WBV exposure. Additionally, phase shift between the HAV and WBV, and possible gender differences were evaluated.

### Methods:

Twelve healthy male volunteers and ten healthy female volunteers participated in this study. The subjects were seated on a wooden seat mounted on shaker, gripping a bicycle type straight handlebar, mounted on a HAV shaker. The magnitude of the frequency-weighted acceleration was  $5.0\text{m/s}^2$  for the HAV and  $1.1\text{m/s}^2$  for the WBV, which corresponds to the exposure limit values established in the European vibration directive. Surface EMG was collected from the right upper trapezius during 30s of HAV and WBV exposure in four different conditions, 1. Only HAV; 2. Only WBV; 3. HAV+WBV in phase; 4. HAV+WBV 180° phase shifted.

### Results:

The normalized EMG amplitude of the trapezius was higher for the two combinations of exposures compared to exposure only to HAV or WBV (121% vs. 105-110%), but no difference between the two combinations was found. The EMG frequency was slightly higher in the phase shifted combination (105%) compared to all other exposures condition (103%). The repeated measures analysis showed a significant effect of type of exposure on the amplitude and frequency of the trapezius EMG. The Bonferroni post hoc analysis showed a significant difference of the EMG amplitude between WBV and the combined HAV+WBV in phase. No gender differences were found concerning the effect of combined vibration exposure.

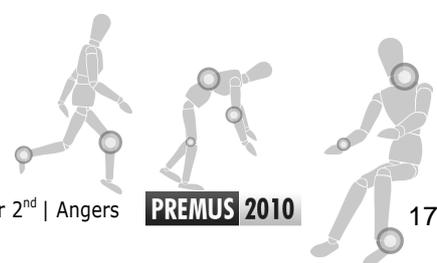
### Conclusion:

This study shows that a combination of HAV and WBV exposures, regardless of phase between the two, causes a higher muscle activity in the trapezius muscle compared to HAV and WBV exposure separately. This might help explain the high prevalence of symptoms in the neck in drivers of terrain and off-road vehicles.

**Keywords:** Muscle activity, Vibrations, driving, Neck

### References:

Larsson B, Sogaard K, Rosendal L. Work related neck-shoulder pain: a review on magnitude, risk factors, biochemical characteristics, clinical picture and preventive interventions. *Best Pract Res Clin Rheumatol* 2007;21(3):447-63.  
Gummesson C, Isacsson SO, Isacsson AH, Andersson HI, Ektor-Andersen J, Ostergren PO, et al. The transition of reported pain in different body regions--a one-year follow-up study. *BMC Musculoskelet Disord* 2006;7:17.



**RELATIONSHIPS BETWEEN FOREARM AND TRAPEZIUS MUSCLE ACTIVITY DURING KEY TAPPING**

TOMATIS L., MÜLLER C.H., NAKASEKO M., LÄUBLI T.H.

*Division of Public and Organizational Health, University of Zurich & Swiss Federal Institute of Technology Zurich (ETH Zurich), Weinbergstrasse 109, CH-8092 Zurich, Switzerland***Aims:**

Work-related musculoskeletal disorders (MSD) in neck and shoulder have been reported to be a major health problem in computer workers (Ming et al. 2004). An explanation for such MSD could be the continuous activation of the Trapezius muscle (TR) during low intensity work. Therefore an experimental study was performed to investigate, whether -depending from the forearm muscle activation- the TR is active during repetitive key-tapping.

**Methods:**

The muscle activity of forearm and trapezius muscles during repetitive key-tapping with supported arm and wrist was investigated. Thirteen right-handed subjects (7 women, 6 men,  $29.7 \pm 11.4$  years) participated in the experiment. Surface EMG of the finger extensor and flexor muscles and the TR was recorded unilaterally while the subject performed ten sessions of two minutes key-tapping at 4Hz using a different key make (different force-displacement characteristics) each time in a randomized order. The EMG signal was cut from on-to-on (key press to key press) using the onset signal of the keyboard. A cross-correlation procedure was performed to describe the dependency between forearm and TR muscle activity. Further, the time shift between peak activity of flexor, extensor and TR was determined. Mixed models were used to calculate the effects of the different subjects and keys on the cross-correlation parameter and time-shift.

**Results:**

Results showed that the TR activity was highly correlated with flexor and extensor muscles ( $0.93 \pm 0.05$ , each). The time-shift between the peak activities varied greatly (in percent of tapping cycle length: flexor-TR  $46\% \pm 24\%$ , extensor-TR  $47\% \pm 24\%$ ) and was highly dependent on the subject ( $p < 0.001$  for both). The different key makes did not significantly influence the relationship between flexor and TR ( $p = 0.10$ ) or extensor and TR ( $p = 0.11$ ) activity.

**Conclusion:**

The presence of key-tapping dependent TR activity seems to be biomechanically unnecessary, as the wrist and arm were supported, and therefore leads to the conclusion, that it is caused by individually acquired, inappropriate motor programs. Although these mechanisms cannot be directly linked with the development of MSD, it should be considered as a risk factor. To gain a better understanding of the observed unnecessary TR activity, questions on motor control should gain more attention in ergonomic studies.

**Keywords:** Muscle activity, Postures, physical exposure, Personal risk factors for MSD

**Reference:**

Ming, Z., M. Narhi, et al. (2004). "Neck and shoulder pain related to computer use." *Pathophysiology* 11(1): 51-56.



## COMPARISON OF TIME AND LEVEL BASED EMG PARAMETERS FOR ASSESSMENTS OF MUSCLE ACTIVITY PATTERNS

VEIERSTED K.B., FORSMAN M., MATHIASSEN S.E.

National Institute of Occupational Health, Oslo, Norway

### Aims:

Sustained trapezius muscle activity has been shown to increase the risk of neck and shoulder pain: number of eight-minute-periods with sustained activity  $>0.5\%$  EMGmax (Østensvik 2009), and more than 70% of burst time, i.e. working time above  $2\%$  EMGmax (Mork 2006). Both studies consider the occurrence of continuous muscle activity above a certain discrimination level. The aim of this study was to evaluate the effect of data processing procedures on similar measures of sustained trapezius muscle activity.

### Methods:

Full-day bilateral EMG from upper trapezius muscles were collected from forty subjects (17 men, 23 women, median age 22 years, range 22-26), who had just left technical school and started mainly as hairdressers, electricians and students. Number of periods and total duration of activity above discrimination levels 0.5, 1 and  $2\%$  EMGmax were retrieved from data processed by each of six Root Mean Square (RMS) window lengths. Several analyses of patterns of activity and rest were made, and this paper presents some basic descriptives concerning total duration of muscle activity.

### Results:

The static muscle activity level (APDF) was  $0.3\%$  EMGmax and the mean burst time was 65%. The total time of muscle activity depended largely on the discrimination level (Figure: panel A compared to B). For all discrimination levels, the total activity time increased with an increasing RMS length, and became larger when the demands for a minimum period duration were relaxed (figures A and B).

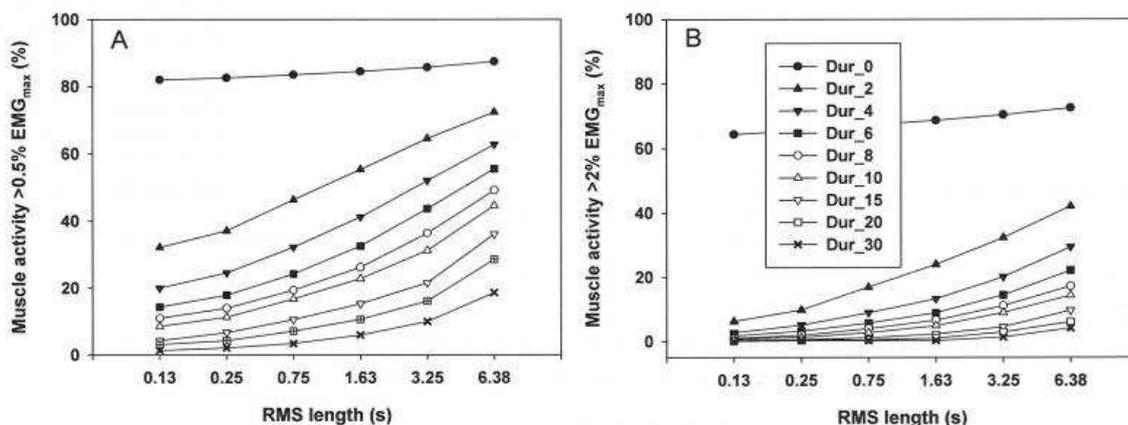


Figure. Relative total time of muscle activity periods  $>0.5\%$  EMGmax (A) and  $>2\%$  EMGmax (B) dependent on minimum duration of periods (0-30 min) and RMS length for right upper trapezius muscle (N=40)

### Conclusion:

Thus, muscle activity patterns extracted from EMG are highly sensitive to the data processing procedure and we suggest that a standardized approach should be developed so that future studies will be comparable.

**Keywords:** Mechanism of pain and tissue injury, Muscle activity, Exposure measurement methods

### References:

- Mork PJ, Westgaard RH. Low-amplitude trapezius activity in work and leisure and the relation to shoulder and neck pain. *J Appl Physiol*, 2006; 100:1142-1149
- Østensvik T, Veiersted KB, Nilsen P. A method to quantify frequency and duration of sustained low-level muscle activity as a risk factor for musculoskeletal discomfort. *JEK*, 2009; 19:283-294.



## COMPARING POWER TOOL FASTENING AND UNFASTENING OPERATIONS: EXPOSURES AND PHYSIOLOGICAL RESPONSE

LIN J.H., MCGORRY R.W., BANKS J.

Liberty Mutual Research Institute for Safety, Hopkinton, MASSACHUSETTS, USA

### Aims:

Powered hand tools have the potential to produce reaction forces associated with upper extremity musculoskeletal disorders (Radwin et al. 1989). Fastening is the dominant task in the industry and focused in the literature, while unfastening has never received much attention in research. In the fastening process, the powered tool torque buildup follows an exponential function (Lin et al. 2003). In contrast, for an unfastening operation the torque required to loosen a joint is maximum at the beginning of the process. This study compared the kinetic and physiological impacts on the operator upper extremities between the fastening and unfastening operations.

### Methods:

Thirty-two healthy male operators completed various matching fastening and unfastening tasks using pistol grip and right angle tools at different working heights, distances, and orientations in the laboratory. Grip force was measured on an instrumented handle attached to each tool. Muscle activity was monitored at the wrist flexor and extensor, and the upper trapezius of the right arm.

### Results:

Paired t-tests showed that when pistol grip tools were used, the peak torque to unfasten a joint (3.7 Nm) was significantly less than to fasten the same joint (5.7 Nm). However, the exposure time was longer for unfastening cycles (98 ms more on the horizontal surface, and 107 ms more on the vertical surface). The average grip force scaled to corresponding peak tool torque revealed that the effort to react against torque was greater in unfastening cycles than in fastening cycles for all work configurations. It also showed that as a proximal stabilizer, the upper trapezius muscle had a greater activity in unfastening cycles.

**TABLE: Mean differences (fastening – unfastening) and t-test *p*-values between paired fastening and unfastening cycles for seven performance and four efficiency variables when pistol grip tools were used on the vertical surface.**

	Difference	p-value
Exposure time (ms)	-107.5	<0.001
Peak tool torque (Nm)	2.0	<0.001
Reaction moment impulse (Nm·s)	0.002	0.897
Average grip (%MVC)	13.4	<0.001
Integrated FDS EMG (%RVC·s)	-52.60	<0.001
Integrated EDC EMG (%RVC·s)	-21.12	<0.001
Integrated UT EMG (%RVC·s)	-38.46	<0.001
Average grip/Peak torque	-4.6	<0.001
FDS IEMG/Peak torque	-18.79	<0.001
EDC IEMG/Peak torque	-20.95	<0.001
UT IEMG/Peak torque	-18.01	<0.001

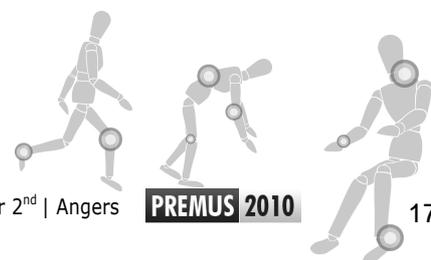
### Conclusion:

The kinetic and physiological responses demonstrated that unfastening fasteners has the potential to increase risk for musculoskeletal disorders, and should be considered in ergonomics assessment in the workplace.

**Keywords:** Muscle activity, Postures, physical exposure, Upper limb

### References:

Lin, J.-H., R.G. Radwin, T.G. Richard, and F.J. Fronczak. Forces associated with pneumatic power screwdriver operation: statics and dynamics. *Ergonomics* 2003; 46: 1161-77.  
 Radwin RG, VanBergeijk EM, and Armstrong TJ. Muscle response to pneumatic hand tool torque reaction forces. *Ergonomics* 1989; 32: 655-73.



## SUSTAINED TRAPEZIUS MUSCLE ACTIVITY AND DEVELOPMENT OF NECK PAIN IN YOUNG WORKERS

HANVOLD T.N., VEIERSTED K.B., WAERSTED M.

National Institute of Occupational Health, Oslo, Norway

### Aims:

The purpose of this study was to investigate a possible association between trapezius muscle activity during work and neck pain in a sample of young workers.

### Methods:

The analyses are based on data from a prospective cohort study of 420 technical school students followed for 6½ years (2002-2009) from technical school into working life. Forty subjects (23 women and 17 men) had surface electromyography (EMG) of the upper trapezius muscle recorded bilaterally during a whole working day (in 2007). In the present analyses these 40 subjects (14 electricians, 15 hairdressers, 5 students and 6 with other occupations, mean age 22 years) were classified into two response categories, low (<70%) and high (>70%), by quantifying total duration of surface EMG activity above 2% EMGmax (EMG bursts) during the working day (Mork, 2006). Neck, shoulder and upper back pain were recorded by questionnaire every year over a three year period (2006-2009). A pain index (0-12) was calculated by multiplying pain intensity (0-3) and pain duration (0-4).

### Results:

The results showed no significant differences in the two “burst time” responses with respect to gender and occupational groups. A higher pain index was reported in the high “burst time” group on the day of the technical measurement and at 1 year follow-up. This difference was not found at the 2 year follow-up. Ten participants changed their occupational status in the follow-up period, but no significant difference in the two “burst time” groups was found.

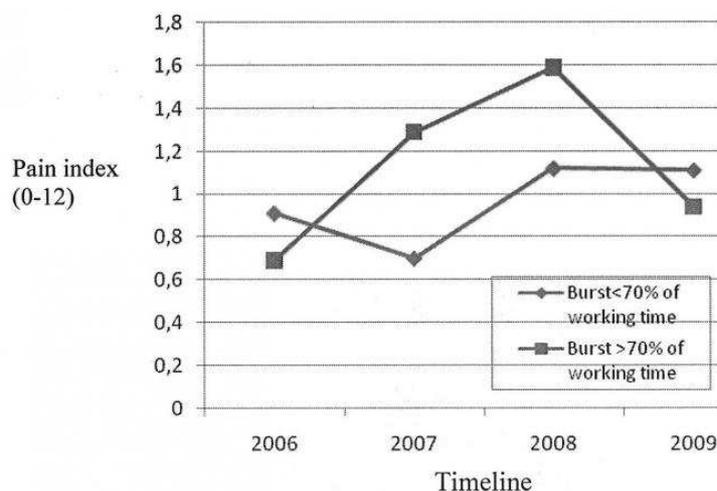


Figure. Mean neck pain in the two EMG burst time groups in 2006 (n=38), 2007 (n=40), 2008 (n=39) and 2009 (n=35). The recording of EMG burst time was done in 2007.

### Conclusion:

The analyses support previous findings (Mork, 2006) that “burst time” in the trapezius muscle >70% of working time may be associated with neck pain. However the relation is not clear in pain reports at follow-up.

**Keywords:** Mechanism of pain and tissue injury, Muscle activity, Neck

### Reference:

Mork P.J., Westgaard R.H. Low amplitude trapezius activity in work and leisure and the relation to shoulder and neck pain. *J Appl Physiol.* 2006;100: 1142-1149



## EVALUATING BICYCLE DESIGN USING SEMG TO STUDY MUSCLE FATIGUE

JAGANNATH M., ADALARASU K., BALASUBRAMANIAN V.

Rehabilitation Bioengineering Group, Department of Engineering Design Indian Institute of Technology Madras, Chennai 600036, India

### Aims:

Bicycle design is necessary to avoid musculoskeletal disorders (MSD), enhance comfort and improve performance. Objective of this study was to investigate the physiological response of cycling on rigid frame (RF) and suspension (SU) bicycles using surface electromyography (sEMG).

### Methods:

Twelve male subjects (20-28 years, 55-69 kg) participated in this study. Subjects rode the bicycles within the Institute premises on consecutive days. The track was designed to cover a distance of 7 km in about 20 minutes. Subjects performed exertions to elicit maximal voluntary contraction (MVC) of the required muscles before and after cycling. sEMG signals were acquired bilaterally from extensor carpi radialis (ECR), trapezius medial (TM), latissimus dorsi medial (LDM), and erector spinae (ES) during MVC test. Time domain features such as root mean square (RMS) and frequency domain features such as mean power frequency (MPF) values were extracted to determine muscle fatigue.

### Results:

Figure 1 shows that more number of subjects got fatigued in case of RF when compared to SU. The analysis shows that there is a significant ( $p < 0.05$ ) differentiate EMG activity in the lower back muscles (right-LDM) group between RF and SU bicycle.

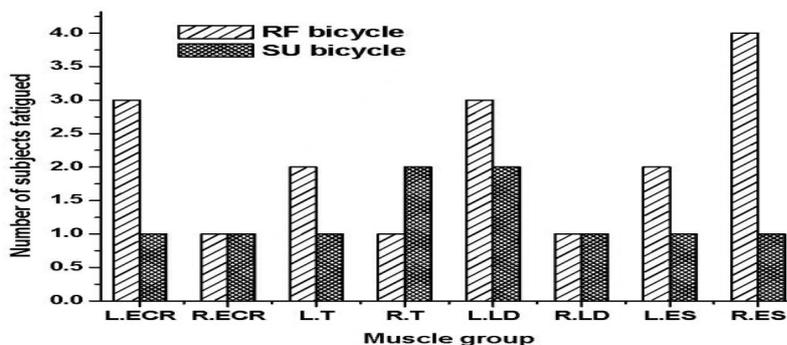


Figure 1. Comparison of number of subjects fatigued for RF and SU bicycles (L-Left, R-Right)

### Conclusion:

While continuous riding, subjects are exposed to vibration and force during which time several muscles are being exercised and lead to muscle fatigue. Increase in the amplitude RMS and decrease in the MPF value of the EMG signal are used as the indication to assess the activity of the muscle being fatigued (Edwards, 1981 and Balasubramanian et al., 2009). Present study indicates that 16.4% increase in RMS value and 13.7% decrease in MPF value of the EMG signal. It is inferred that the physiological response of cycling shows the benefits of fitting suspension systems to bicycles. These inferences should be considered for ergonomic design of bicycles.

**Keywords:** Postures, physical exposure, vibrations, driving, back, low back

### References:

- Edwards R.H. Human muscle function and fatigue. Human muscle fatigue: physiological mechanisms. In: Ciba Foundation Symposium. vol 82; Pitman Medical; London; 1981. p 1-18.  
 Balasubramanian V and Jayaraman S. Surface EMG based muscle activity analysis for aerobic cyclist. Journal of Bodywork and Movement Therapies. 2009; 13:34-42.



## UPPER-EXTREMITY MUSCLE ACTIVITY DURING FLOWERS CUTTING AND PACKING IN A COLOMBIAN WORKING POPULATION

BARRERO L.H., RODRÍGUEZ L.E., SUAREZ N., CAMACHO A.M., CEBALLOS C., QUINTANA L.A., DENNERLEIN J.T.

Javeriana University, Bogotá, Colombia

### Aims:

Upper-extremity (UE) musculoskeletal disorders account for almost 40% of all recorded occupational disease in Colombia [1]. Although the flower industry has been mainly affected by the occurrence of these conditions, little is known about the mechanical demands related to flower production. We aimed to quantify UE muscle activity (MA) during flower production in a sample of Colombian workers.

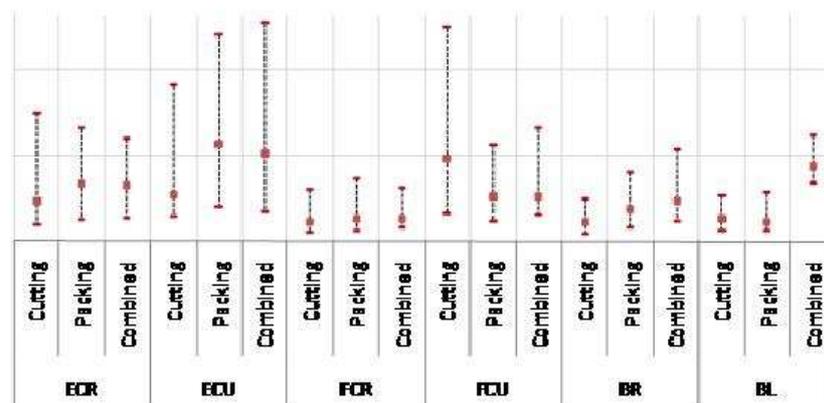
### Methods:

16 workers (11 females, age between 25 and 54 years), from 8 different companies were recruited. We studied three tasks, cutting flowers, packing flowers, and a combination of those tasks. We assessed task durations and surface electromyography (EMG) for the extensor carpi radialis (ECR), flexor carpi radialis (FCR), extensor carpi ulnaris (ECU) and flexor carpi ulnaris (FCU) of the right arm, and the right biceps (RB) and left biceps (LB), according with SENIAM guidelines [2]. We calculated the average, 10th, 50th and 90th percentile for the RMS normalized EMG amplitude signal for each task and worker.

### Results:

Average median MA across tasks ranged between 7% and 23%. Forearm muscles, and particularly those related to ulnar movements were mainly active across all tasks. While no statistically significant differences were found between tasks, the FCU MA appears to be noticeably higher during the cutting task in comparison to packing and combined tasks (Figure 1). However, cutting tasks occurred during about 30% of the work shift while packing and combined tasks occurred during at least 70% of it.

Figure 1. Average 10<sup>th</sup>, 50<sup>th</sup> and 90<sup>th</sup> percentile for the RMS normalized EMG amplitude signal by task and muscle



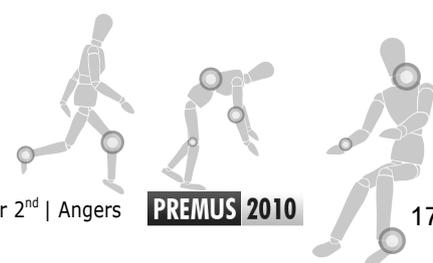
### Conclusion:

Manual work in the flower industry frequently results in median MA above 10% MVC, comparable to those reported in other manually demanding tasks. [3] Combining cutting and packing tasks do not appear to result in lower demands than when tasks are conducted separately. Interventions should be focused on reducing the ulnar-flexion-related load, particularly during the cutting task.

**Keywords:** Muscle activity, Agriculture, Upper limb

### References:

- Tafur, F.J., Informe de enfermedad ocupacional en Colombia 2003-2005, ed. Ministerio de la Protección Social. 2007, Bogotá: Imprenta Nacional de Colombi
- Hermens JH, Freriks B, Merletti R et al. 1999. European Recommendations for Surface Electromyography. 2nd edition. Roessingh Research and Development.
- Juul-Kristensen B., Fallentin N, Hansson G-A, et al. 2002. Physical workload during manual and mechanical deboning of poultry. Int J Ind Ergon 29: 107-115.



## EMG-ANT – A SOFTWARE PACKAGE FOR ANALYSIS AND COMPARISON OF SURFACE ELECTROMYOGRAPHY DATA IN OCCUPATIONAL MEDICINE

BORCH H., EINSIEDLER K., RIEGER M.A.

*Institute of Occupational and Social Medicine, University Hospital of Tübingen, Germany*

### Aims:

Analysis of data collected by utilizing surface electromyographical (EMG) methods often causes trouble. Especially comparison of EMG signals derived from various investigations may be associated with many problems because of variances e.g. in electrode application, muscular behavior and motion sequences. Within this project, a software package has been developed which provides multiple tools and methods to assist the joined visual and mathematical evaluation and comparison of EMG data from different origins.

### Methods:

Configurable moving average is used to smooth EMG data before analysis. Single EMG signals are analyzed by calculating mean values, minimum and maximum envelopes as well as the signals' static and dynamic parts. Muscle fatigue analysis contains linear and multiple regression of the muscle's electric activity and median frequency. Multiple EMG signals are standardized by defining reference values. In addition, they can be rectified by setting multiple reference time points during measurement or data analysis or rather by using an algorithm which is inspired by alignment methods from bioinformatics. This algorithm also computes a distance measure between multiple EMG charts, optionally respecting offsets and different signal scaling. A set of signals can be subsumed by calculating a mean chart.

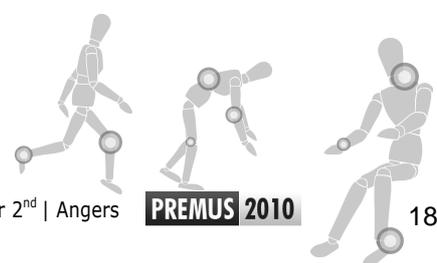
### Results:

The software package EMG-AnT (EMG Analysis Tool) is able to read and handle raw and preprocessed EMG signal data in text file format. All analysis results can be visualized graphically and, in turn, be exported in text file format. Besides the display of the mathematical analyses' results, visual analysis includes the plotting of one or more EMG charts. Plotting and replotting are done in real time for zooming and scrolling as well as for smoothing and standardizing, in order to support the user in establishing well working parameters.

### Conclusion:

EMG-AnT has been primarily developed to assist the analysis of electromyographical data in occupational medicine. It will still be refined and expanded in order to facilitate analysis and comparison of EMG data sets. In the near future, work will be focused on integration of algorithms calculating, evaluating and plotting frequency spectrums over time using Fast Fourier Transformation. Thus, automatic detection of muscular fatigue can be expanded. Additional tasks might be the computation and comparison of muscular strain as well as the calculation of risks for muscular hardening and morphological changes (e.g. RSI).

**Keywords:** Biomechanics, muscle activity, exposure measurement methods



**CHANGE OF ELECTROGONIOMETRIC AND TORSIOMETRIC SENSORS ACCURACY WITH USAGE.**

CARNAZ L., MORIGUCHI C.S., GIL COURY H.J.C.

*Physiotherapy Department, Federal University of São Carlos, São Carlos-SP, Brazil.***Aims:**

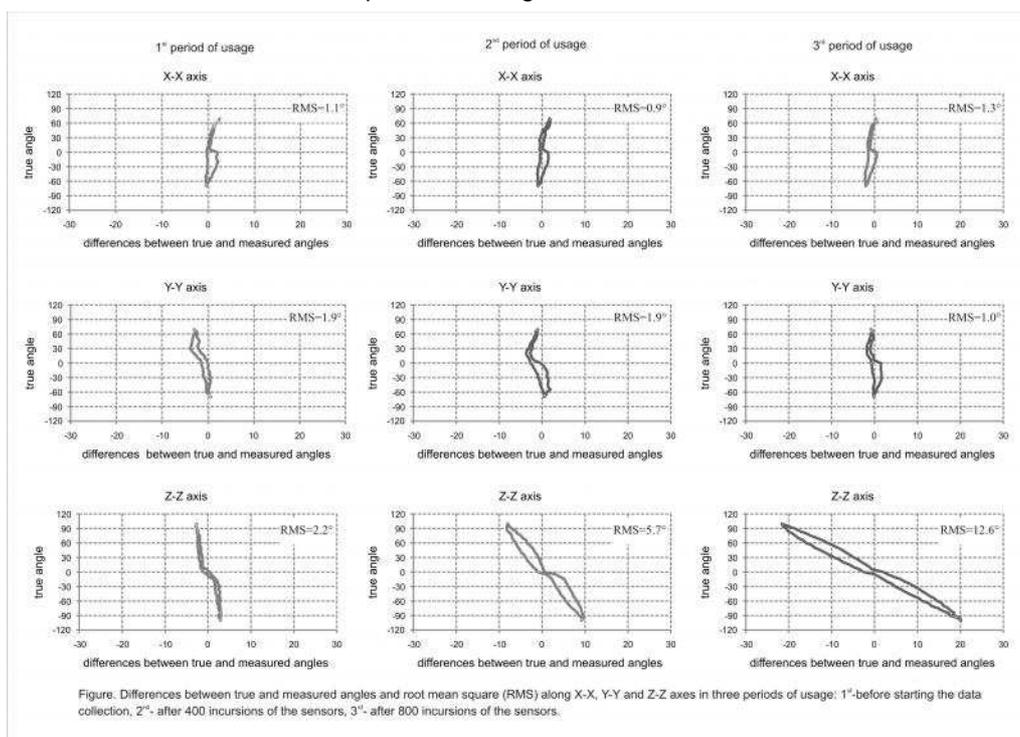
Portable electrogoniometer and torsiometer are handy tools for measuring movements in occupational settings. However, they might be affected by usage. Thus, the aim of this study is to evaluate the accuracy of electrogoniometer and torsiometer used to record movements along X-X, Y-Y and Z-Z axes in three different periods of usage.

**Methods:**

One biaxial electrogoniometer M110 and one torsiometer Q110 (Biometrics Ltd., UK) were evaluated. The data were recorded at 20Hz by an acquisition unit (Biometrics Ltd, UK). For simulating isolated angles in three axes of movement, two precision gauging devices were used. Each sensor was attached at the device and the movements were recorded for a  $\pm 70^\circ$  range of motion along X-X and Y-Y axes and  $\pm 100^\circ$  along Z-Z axis, with an increment of  $5^\circ$  between each measurement. This procedure was performed for each sensor in three different occasions: 1) before starting a data collection 2) after 400 incursions of the sensors 3) after 800 incursions of the sensors. Differences between angles measured by the sensors and by the gauging device were used to plot X-Y graphs and to calculate the root mean square (RMS).

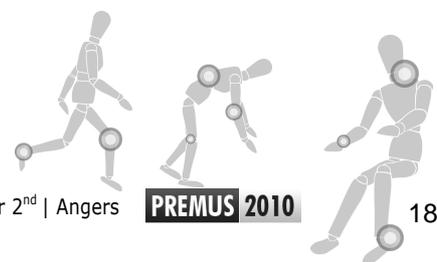
**Results:**

Differences between true and measured angles remained almost constant for electrogoniometer measurements; the greatest differences among the three periods of usage considering RMS were  $0.4^\circ$  and  $0.9^\circ$  along X-X and Y-Y axes, respectively. However, for the torsiometer a difference of  $10.4^\circ$  along Z-Z axis was found between the first and the third period of usage.

**Conclusion:**

Electrogoniometer accuracy did not suffer with usage after a full data collection demonstrating that it is a useful tool for measurements in workplace. However, torsiometer presented expressive change in its accuracy. Therefore, it is advisable that this equipment be checked for change during use in large data collection.

**Keywords:** Biomechanics, Postures, Physical exposure, Exposure measurement methods



## PROTOCOL FOR EVALUATING TRUNK MOVEMENT DURING LIFTING TASKS PERFORMED IN REAL WORK SITUATION

CASTILLO J.A., OROZCO. A.

*Ergomotion-Lab, Health, Work and Cognition Research Group, Medicine & health sciences school, Rosario University, Bogota, Colombia.*

### Aims:

The aim of this research is to establish parameters to identify and analyze kinematic variables of trunk movement during load lifting. We must find some references for understanding how movement occurs, what are the major transitions and parameters through which these elements can be analyzed.

### Methods:

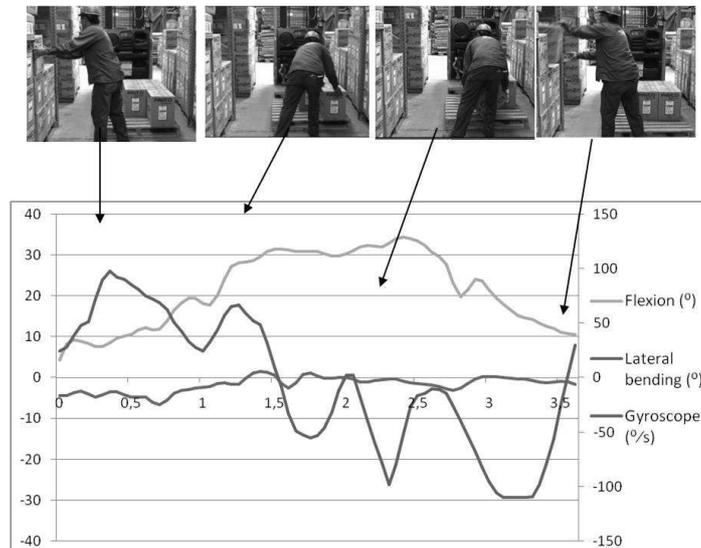
This study compares the results of kinematics analyses of trunk movement during lifting tasks captured by portable inertial sensors, activity analysis, and work observation in real situations with video recording. The study will be performed in a warehouse used to store plastic pipes of different sizes. Six workers with any history of musculoskeletal problems were the participants.

The variables of interest were peaks in trunk flexion angles, peaks in trunk rotation angles, velocity and acceleration during load-lifting tasks. One standardized experimental set-up was used. For the purpose of the methodology each lift was divided in two phases: Going downwards (and grasp the box) and Going upwards (lifts the box and place it on the surface on the subject's left side. Thus this phase includes also rotation. In some lifts this rotation phase could be separated from the upward phase).

### Results:

The parameters evaluation of trunk kinematics during load lifting, should integrate two central aspects: the first one related to events occurring in the workplace which modify the velocity and acceleration and displacement trajectories. The second one is reflected in the modification of the gesture in those events.

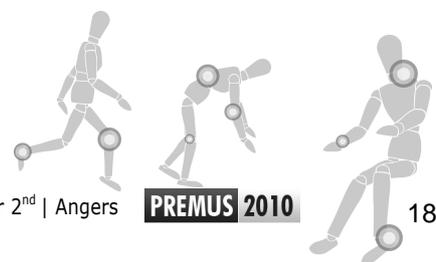
The variation of trunk flexion angles in the sagittal plane is influenced by motor control processes, and this angle may change quickly at the beginning and end of the action, it is also influenced by rotation and lateral deviations, base of support, height and final destination of the load.



**Figure . Example of one lift situation (up to down to up) for the worker at the company, lifting 17,5 kg during approximately 3,5 seconds measured simultaneously with the goniometer (flexion and lateral bending) and the gyroscope (rotation).**

### Conclusion:

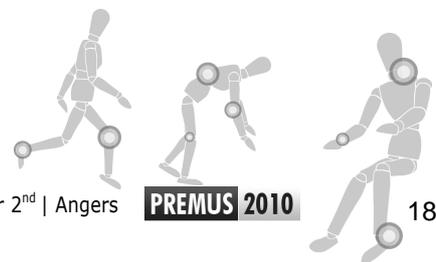
A limitation of the use of inertial sensors that is orientation in 3D is affected by magnetic disturbances [3]. A limitation of this study is the number of participants; however the results indicate the adjustments necessary to develop a more comprehensive study. Another limitation relates to the complexity of trunk movement, in laboratory testing conditions was observed closer to the theoretical models. The trials in workplace show that the composition of the trunk movement is more complex and is linked to the properties of the working settings, which changes the gesture, posture and lifting speed among other parameters



**Keywords:** Biomechanics, Postures, Intervention methods.

**References:**

- [1] Bazrgaria, B., Shirazi-Adla, A., Trottierb, M. and Mathieub, P.,. Computation of trunk equilibrium and stability in free flexion–extension movements at different velocities. *Journal of Biomechanics* 41, 412–421. 2008
- [2] Castillo, J. Cubillos, A. Orozco, A. Valencia, J. El análisis ergonómico de la actividad y las lesiones de espalda en trabajadores de sistemas de producción flexible. En *Revista Ciencias de la salud*. 2007. Volumen 5 No 3 ISSN. 1692-7273.
- [3] Roetenberg, D., Luinge, H.J., Baten, C.T.M., Veltink, P.H., 2005. Compensation of magnetic disturbances improves inertial and magnetic sensing of human body segment orientation. *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 13 (3), 395–405.



## EFFECT OF BACKPACK WEIGHT ON POSTURAL ANGLES IN THAI SCHOOL CHILDREN

CHAIKUMARN M.

*Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok, Thailand*

### **Aims:**

Carrying heavy backpack load leads to alteration in various postural angles. These alterations could lead to the development of musculoskeletal disorders among children in the near future.

The aim of this study is to determine the changes in postural angles at different backpack weights in school children.

### **Methods:**

Healthy male school-children (n=30), age 13.5 (+0.4) years, from junior high schools. Measurements: Bodyweight of children were measured. The carrying weight were 0%, 5%, 7%, and 10% of the bodyweight were calculated and implemented. The still pictures were taken at 0%, 5%, 7%, and 10% of individual body weight. The craniocervical (CV), head on neck (HN), head and neck on trunk (HNT), and trunk inclination (TI) angles were analyzed from photographs by the UTHSCSA ImageTool v.3.

### **Results:**

The CV angle changed significantly at a carrying load of 5% body weight ( $P < 0.05$ ). The HN and HNT angles changed significantly after 10% ( $P < 0.05$ ). The trunk inclination angle was also changed significantly at 10% of body weight ( $P < 0.05$ ).

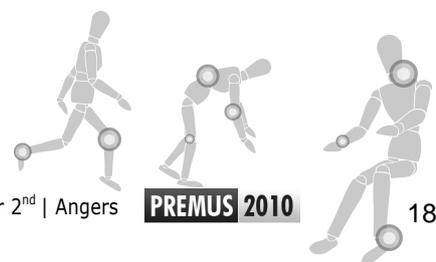
### **Conclusion:**

Carrying a backpack weighing from 5% of body weight could alter the postural angles among school children.

**Keywords:** Biomechanics, postures, physical exposure, other

### **References:**

McEvoy MP, Grimmer K. Reliability of upright posture measurements in primary school children. *BMC Musculoskelet Disord.* 2005 Jun 29;6:35.  
Chansirinukor W, Wilson D, Grimmer K, Dansie B. Effects of backpacks on students: measurement of cervical and shoulder posture. *Aust J Physiother.* 2001;47(2):110-6.



## ARE EXPERIENCED WORKERS MORE STABLE WHEN HANDLING LOADS?

DELISLE A., PLAMONDON A., SALAZAR E., DENIS D. AND THE MANU GROUP

*Faculté d'éducation physique et sportive, Université de Sherbrooke, Sherbrooke, Canada; Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST), Montréal, Canada.*

### Aims:

Manual material handling (MMH) is known as a risk factor for low-back pain. Maintaining balance while handling a load, which can be seen as an external disturbance, could be important for safe handling strategies. Unfortunately, balance control while performing MMH has received little attention. The aim of this study was to compare experienced with novice handlers regarding their stability while performing a transfer task from a conveyor to a hand trolley.

### Methods:

Fifteen experienced (years of experience: Mean = 15.4 yrs, SD = 9.3) and 15 novices (Mean = 0.5 yr, SD = 0.4), all men, were invited in our lab and had to perform series of box transfers under conditions similar to those of large distribution centres. The task consisted of transferring four different types of box (3 boxes of 15 kg and one of 23 kg) from a conveyor to a hand trolley. Only the transfer of the 23-kg box on the pile of the three other boxes (96 cm high) was analyzed here. The distance between the conveyor and the trolley was 1.50 m. The handlers were free to choose their lifting techniques and there was no restriction on how to move. The only instruction given to the subjects was to handle the load the way they usually do. A large force plate and an optoelectronic system were used to measure ground reaction forces and whole body kinematics. The destabilizing force that would need to be applied to the subject's centre of gravity in order to bring his center of pressure out of his base of support was computed (Delisle et al. 1998).

### Results:

There was no difference in the destabilizing force during the lifting phase between the two groups (mean = 175 N; SD = 48 N). During the deposit phase, the destabilizing force was larger for experienced workers (mean = 62 N; SD = 12 N) than novices (mean = 54 N; SD=12 N), revealing greater stability for experienced workers ( $p < .05$ ).

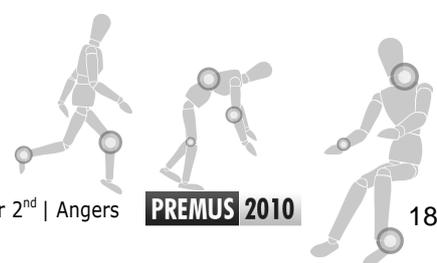
### Conclusion:

It has been reported that experienced workers have less lumbar flexion and trunk inclination, and that they keep the load closer to their body (Plamondon et al., this conference). Such strategies may help provide greater stability at the time when the box is to be dropped, in anticipation of a balance disturbance. Understanding strategies that offer better stability might prove important in preventing injuries in MMH.

**Keywords:** Biomechanics, postures, physical exposure, back, low back

### References:

Delisle A, Gagnon M, Desjardins P. Knee flexion and base of support in asymmetrical handling: effects on the worker's dynamic stability and the moments of the L5/S1 and knee joints. *Clin Biomech* 1998; 13:506-514  
Plamondon A, Delisle A, Denis D, Larivière C, St-Vincent M, Salazar E et al. Manual materials handling: expert handlers use different lifting strategies than novices. PREMUS 2010. Angers, France.



## EXPERIENCED MANUAL MATERIALS HANDLERS ARE MORE EFFICIENT TO REDUCE LUMBAR SPINE LOADING

GAGNON D., PLAMONDON A., SALAZAR E., DELISLE A., DENIS D., LARIVIÈRE C., ST-VINCENT M., NASTASIA I.

*Faculté d'éducation physique et sportive, Université de Sherbrooke, Canada*

### Aims:

Ergonomic studies indicate that experienced workers have acquired techniques that might help define the content of training programmes. Much biomechanical bases of these techniques remain to be documented and translated into precise instructions/principles to impact workplace practices. The goal of the present study was to compare experienced and novice manual materials handlers. It was hypothesized that the experienced handlers would be biomechanically more efficient to reduce lumbar spine loading.

### Methods:

Experienced (mean=15.4 yr of experience, N=15) and novice (mean=0.5 yr, N=15) workers were selected to simulate series of box transfers. Four different boxes (15 or 23 kg) were lifted and carried from a conveyor to a hand truck (total 128 lifts/ session). Workers were asked to handle the boxes the way they usually do without instructions on how to move. External forces, 3D kinematics, surface EMG, and maximal exertions were recorded. Net joint loadings from 3D inverse dynamics were input to a 76-muscle EMG-driven lumbar spine model. Statistical analyses demonstrated that novice handlers flexed significantly more their lumbar spine but without between-group impact on the L5-S1 maximal resultant moment. To clarify these apparently contradictory results, one worker of similar mass and size was selected from each group for detailed comparative analyses. Postures corresponding to maximal L5-S1 resultant moment were processed by the lumbar spine model.

### Results:

For the novice, the torsion component of the joint moment was 2.6 (T12-L1: 41 vs. 16 Nm) to 3.8 (L5-S1: 31 vs. 8 Nm) times larger. Larger lumbar spine flexion by the novice stretched much more its back muscles and ligaments. This doubled passive muscle forces and generated additional (co)active forces in the abdominal muscles (novice: 300-500 N; expert: 10-100 N). There was a clear penalty for the novice with more compression force exerted at all lumbar joints (L5-S1: 48%; T12-L1: 40%).

### Conclusion:

On the one side, the techniques used by the experienced worker were efficient to reduce lumbar spine loading and that may be associated to the low injury record (this was a criterion for inclusion) of this group. On the other, repeated large lumbar spine loading might lead novice handlers to injury if efficient strategies are not learned early enough. Training should target the novice handlers with appropriate instructions without delay. These promising preliminary results support additional detailed analyses on the entire dataset.

**Keywords:** Biomechanics, Postures, physical exposure, Back, low back



## CAN WE IDENTIFY WORKERS AT RISK OF DEVELOPING KNEE OA USING GAIT KINEMATIC PARAMETERS?

GAUDREAU N., VILLALOBOS E., HAGEMEISTER N., DEGUISE J.

*École de réadaptation, Faculté de médecine et des sciences de la santé, Université de Sherbrooke, Sherbrooke, Canada.*

### Introduction:

Mechanical loading, an important factor in knee osteoarthritis (OA) development, can be related to obesity, involvement in intense sports, heavy load occupational activities or biomechanical alteration of the knee. Altered kinematics during gait can relocate joint contact force to areas of the knee cartilage not adapted to receive this load, resulting in degenerative changes. Therefore, measuring knee kinematics can be a useful tool in identifying persons possibly at risk of developing knee OA. The goal of this gait study was to compare knee kinematics of workers exposed to loading of their knees to persons involved in sedentary occupational activities.

### Methods:

Kinematic data were collected during the gait of 24 participants exposed to occupational knee loading (intense walking, climbing stairs, kneeling, weight lifting). The Baecke questionnaire was used to quantify participants' exposure to physical activities in three domains: sports, leisure and work. Flexibility of lower extremity muscles was also measured. Participants were asked to walk on a treadmill at a comfortable gait speed. 3D kinematic data were recorded using an electromagnetic motion tracking system (Fastrack, Polhemus, USA) using a knee attachment device fixed to the femur and tibia. The gait of 10 participants not exposed to occupational heavy load was also evaluated. The following parameters were extracted and used for group comparison: knee angle at initial contact, peak knee flexion angle during loading response and angle range. Group comparison for variables of interest was performed with paired t-tests.

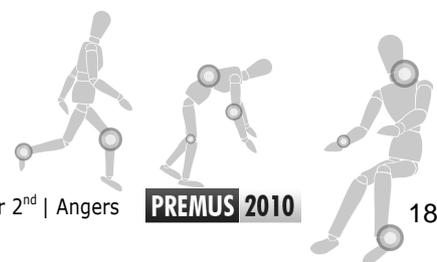
### Results:

Workers exposed to loading had a greater score on the work index of the Baecke questionnaire than did sedentary workers ( $3.7 \pm 0.4$  vs.  $2 \pm 1.3$ ,  $p=0.00$ ). No difference was found between the groups for flexibility of the lower limb muscles. As regards kinematic variables, workers exposed to loading had greater knee flexion and adduction angles at initial contact than did sedentary workers (flexion angle:  $13.4^\circ \pm 7.9$  vs.  $7^\circ \pm 4.4$ ,  $p=0.03$ ; adduction angle:  $6.5^\circ \pm 3.3$  vs.  $2.6^\circ \pm 5.9$ ,  $p=0.02$ ).

### Conclusion:

Increased knee flexion in early stance may increase eccentric contraction of the knee extensors. This can overload the patella and result in patello-femoral knee OA. Knee adduction has been shown to be correlated to high adduction moments, which can lead to excessive loading on the medial compartment and medial knee OA. The workers of the present study demonstrated knee kinematics that may predispose them to development of knee OA.

**Keywords:** Biomechanics, Mechanism of pain and tissue injury, Early prevention.



## COMPREHENSIVE ANALYSIS OF THE PAINFUL TRAPEZIUS MUSCLE USING A PROTEOMIC METHOD

HADREVI J.<sup>1,2</sup>, GHAFOURI B.<sup>3,4</sup>, GERDLE B.<sup>3,4</sup>, LARSSON B.<sup>3,4</sup>, PEDROSA-DOMELLÖF F.<sup>2</sup>, HELLSTRÖM F.<sup>1</sup>

<sup>1</sup> Centre for Musculoskeletal Research, University of Gävle, Gävle, Sweden - <sup>2</sup> Integrative Medical Biology, Anatomy, Umeå University, Umeå, Sweden - <sup>3</sup> Rehabilitation Medicine, Faculty of Health Sciences, Linköping University, Linköping, Sweden - <sup>4</sup> Pain

### Aims:

The underlying biochemical mechanisms behind trapezius myalgia are not yet fully elucidated. It has been suggested that individuals with trapezius myalgia has an altered muscle metabolism in the trapezius muscle in relation to healthy individuals [1,2]. Until now, no comprehensive study comparing myalgic and healthy trapezius muscle has been conducted. Here we present a study analyzing the differences in protein abundance between healthy and myalgic trapezius using a proteomic method, enabling analysis of a large number of both metabolic as well as structural proteins simultaneously.

### Methods:

Muscle biopsies from 12 healthy women and 12 women with trapezius myalgia were obtained from the descending part of the trapezius, using open surgery biopsy. The muscle biopsies were analysed with two-dimensional difference gel electrophoresis (2D-DIGE), thus enabling an unbiased protein analysis of expressions and modifications of thousands of proteins and enzymes simultaneously, within a limited pH and molecular weight range. The 2D-DIGE method has previously been shown to be a good screening tool to detect biochemical differences between the trapezius and vastus lateralis muscles [3]. In identifying the protein spots deriving from this analysis, matrix assisted laser desorption ionisation time of flight (MALDI-TOF) mass spectrometry is being used.

### Results:

Using 2D-DIGE and MALDI-TOF mass spectrometry, a more comprehensive picture regarding the presence of metabolic enzymes is provided since a large number of proteins are being detected in trapezius muscles from both healthy women and women with trapezius myalgia. Statistical analysis and identification of proteins are currently being conducted.

### Conclusion:

2D-DIGE enables a simultaneous analysis of a large number of proteins in the trapezius muscle. The differences in protein abundance between myalgic and healthy trapezius muscle may provide further clues regarding the metabolic state of the myalgic trapezius muscle. In addition, identified proteins may provide new insights into mechanisms behind trapezius myalgia, especially concerning functions of different enzymes involved in metabolic pathways. The results may give directions to what biomarkers are relevant to investigate with other less invasive methods.

**Keywords:** Mechanism of pain and tissue injury, biomarkers, neck

### References:

1. Larsson, B., et al., Blood supply and oxidative metabolism in muscle biopsies of female cleaners with and without myalgia. *Clin J Pain*, 2004. 20(6): p. 440-6.
2. Rosendal, L., et al., Increase in muscle nociceptive substances and anaerobic metabolism in patients with trapezius myalgia: microdialysis in rest and during exercise. *Pain*, 2004. 112(3): p. 324-334.
3. Hadrevi, J., Human Skeletal Muscle: a basic proteomic approach. Licentiate Dissertation in Medical Science. Department of Integrative Medical Biology, Section for Anatomy, Umeå University, Umeå, Sweden and Centre for Musculoskeletal Research, University of Gävle, Gävle, Sweden 2009, Umeå University: Umeå, Sweden



## UPPER LIMB MUSCULOSKELETAL DISORDER PREVENTION: AN APPLICATION TO WHEELCHAIR PRESCRIPTION AND CONFIGURATION

LOUIS N., GORCE P.

Laboratoire HandiBio, EA 4322, Université du Sud Toulon-Var, Avenue de l'université – BP20132, 83957 La Garde cedex, France

### Aims:

For wheelchair users, much more than for the others, the upper-limb is the place of most common site of MSDs. Effectively, during wheelchair propulsion, the main risk factors for upper limb MSD are present: movement amplitude and repetition, proximity of joints limits and important vertical forces (INRS, 2007; Putz-Anderson et al., 1997). In this context, the aim of this study is to propose a tool to help the clinician for wheelchair prescription and configuration. Thus, we propose an upper limb MSD early prevention index in relation to patient's anthropometry, muscle recruitment and upper limb kinematics during wheelchair propulsion. Furthermore this work is a contribution to the ANR research project on wheelchair ergonomics ("Système d'Aide au Choix et au Réglage du Fauteuil Roulant Manuel").

### Methods:

Through a synthesis of literature information and in agreement with project clinicians, for each upper limb joint, ergonomic indexes were established to quantify risk of future MSD. Furthermore, relative importance of each joint in upper limb MSD apparition in the wheelchair user's population has been established (Boninger et al., 2005; INRS, 2007; Putz-Anderson et al., 1997). In this study we have tested the established index on ten paraplegic experienced users and ten able-bodied inexperienced users. All subjects were tested for twelve wheelchair configurations: tree seat height (44, 47 and 50cm) combined with four antero-posterior axle positions (-3.0, 0.0, 4.2 and 7.2cm). Propulsion movements were recorded using a six optoelectronic camera VICON 460 synchronise with an 8 muscles EMG system that record activity of: deltoid clavicular, deltoid scapular, triceps brachii, biceps brachii, pectoralis major, trapezius, latissimus dorsi and rectus abdominis. Upper limb MSD risk is computed under Matlab environment.

### Results:

Results show that the index is sensible to upper limb kinematics and muscle recruitment variations due to changes in wheelchair configuration. It is also affected by subject propulsion style and anthropometry. For the paraplegics group results show that high and backward seat positions should be the less constraining whereas for the able-bodied group it will be for high and forward seat positions.

### Conclusion:

MSD risk predicted by our index and difference between the two groups and between subjects are in agreement with current literature. It provides quantitative information on wheelchair configuration with a MSD risk lowering. Of course the chosen configurations must be safe and a long term longitudinal validation study must be performed.

**Keywords:** Biomechanics, Personal risk factors for MSD, Early prevention.

### References:

Boninger ML, Koontz AM, Sisto SA, Dyson-Hudson TA, Chang M, Price R, Cooper RA. Pushrim biomechanics and injury prevention in spinal cord injury: recommendations based on CULP-SCI investigations. *J Rehabil Res Dev* 2005;42:9-19.  
 INRS. Les troubles musculo-squelettiques du membre supérieur. Guide pour les préventeurs (ED 957). Aptel, M.; Cail, F.; Aublet-Cuvelier, A., Paris, France 2007.  
 Bernard BP (Eds). Musculoskeletal Disorders and Workplace Factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. U.S Department of Health and Human Services. NIOSH 1997.



## CHANGES IN SITTING POSTURE DURING COMPUTER WORK

MADELEINE P., SVENDSEN J.H., SAMANI A.

*Laboratory for Ergonomics and Work-related Disorders, Center for Sensory-Motor Interaction (SMI), Dept. of Health Science and Technology, Aalborg University, Aalborg, Denmark*

### Aims:

Computer work is associated with a high prevalence of work-related musculoskeletal disorders (WMSD). A lot of focus has been given to the assessment of the biomechanical load of the shoulder region and the upper extremities. However, we have very little knowledge about the changes in the adopted posture in relation to discomfort development due to prolonged sitting. In this study, we investigated the changes in sitting posture during computer with and without discomfort.

### Methods:

Nine subjects took part in this study. Discomfort ratings, kinetic and kinematic data were recorded for 5 min while performing computer mouse work. Recordings were performed before and after 90 min constrained sitting on a force platform. The number of correct/incorrect graphs and the time necessary for completing graphs were assessed. Body part discomfort index, displacement of the center of pressure in anterior-posterior and medial-lateral directions as well as lumbar curvature were calculated. The mean, standard deviation and sample entropy values were extracted from the center of pressure and lumbar curvature signals. Standard deviation and sample entropy were respectively used to assess the size of variability and complexity of sitting.  $P < 0.05$  was considered as significant.

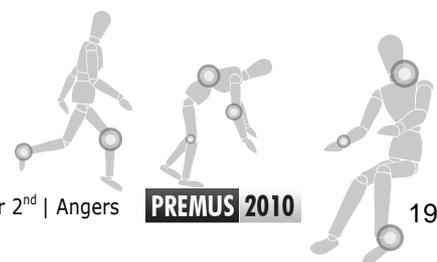
### Results:

Body part discomfort increased from 0 (0) to 7.4 (3.8) after 90 min constrained sitting. The computer performance were changed in presence of discomfort compared with no discomfort as the number of correct graphs increased while the time necessary for completing graphs decreased. The amplitude of the center of pressure displacement and of the lumbar curvature did not change in presence of discomfort compared with no discomfort. On the contrary, the standard deviation of the center of pressure displacement and of the lumbar curvature increased while the sample entropy values decreased ( $P < 0.05$ ).

### Conclusion:

This present study revealed that the size of variability and the complexity of sitting postural control during computer work changes in relation to perceived discomfort. The importance of the dynamics of sitting control may actually challenge the idea of an ideal seated posture. This can be of relevance for studies aiming at preventing WMSD in quasi static postures.

**Keywords:** Biomechanics, computer work



## EFFECT OF ERGONOMIC SCHOOL FURNITURE PROPERTIES ON THE SITTING POSTURE OF CHILD

GERONIMI M., HAMAQUI A.

*Laboratoire de Physiologie de la Posture et du Mouvement (PoM), Centre universitaire JF Champollion, Rodez, France.*

### Aims:

The back pain is the leading cause of sick leave in France. It affects close to 36% of women and 27% of men and it causes, each year, approximately two billion Euros of public health expenditure. In this context, it has been shown a linear increase in the prevalence of back pain with age but also, a positive correlation between the painful occurrence in the childhood and in the adulthood (Harreby, 1995) that prove the interest to focus prevention of the back pain from the earliest age. So, one of main risk factors associated with the back pain of child is the prolonged sitting posture at school (Salminen, 1984). Indeed, standard school furniture induces important spine constraints whereas ergonomic school furniture may be adjusted in order to anthropometric dimensions and preserve natural spine curvatures (Troussier, 1999).

### Methods:

In an experimental protocol, we estimate the constraints of the spinal joints with inertial sensors (Intersense, Bedford, USA) and we quantify muscle fatigue related to maintaining seating posture with an electromyographic system (Aurion, Milan, Italy) in order to the height and the inclination, on the one hand, of the desk, and on the other hand, of the seat. A statistical analysis will be conducted to compare the different studied conditions.

### Results:

Our results should allow a better use of the school ergonomic furniture in class in terms of proposed adjustments and provide recommendations in construction for industry.

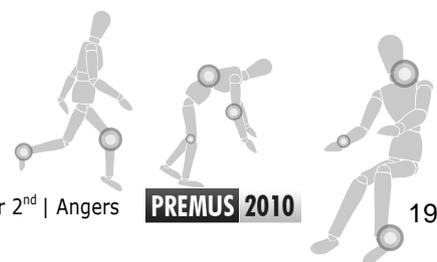
### Conclusion:

Eventually, a longitudinal study may be envisaged to observe the effects of these adjustments on the occurrence of students back pain in the time.

**Keywords:** Biomechanics, muscle activity, postures, physical exposure

### References:

Harreby M, Neergaard K, Hesselsoe G, Kjer J. Are radiologic changes in the thoracic and lumbar spine of adolescents risk factors for low back pain in adults? A 25-year prospective cohort study of 640 school children. *Spine*, 1995; 20:2298-2302.  
Salminen JJ, The adolescent back. A field survey of 370 finnish school children. *Acta Paediatr Scand*. 1984; 315:1-122.  
Troussier B, Tesniere C, Fauconnier J, Grison J, Juvin R, Phelip X. Comparative study of two different kinds of school furniture among children. *Ergonomics*. 1999; 42(3): 516-526.



## EVALUATION OF MUSCLE ACTIVITY, FORCES, STRESSES, AND MOMENTS AT THE KNEE DURING KNEELING AND SQUATTING TASKS

MOORE S.M., POLLARD J.P., PORTER W.L., GALLAGHER S., MAYTON A.G.

*National Institute for Occupational Safety and Health, USA*

### Aims:

Knee injury rates in low working height mines are 10 times greater than in higher mines and may be attributed to exposure to musculoskeletal disorder risk factors (prolonged kneeling, crawling, and twisting on ones knees). Therefore, the National Institute for Occupational Safety and Health has investigated muscle activity, forces, stresses, and moments at the knee (with and without kneepads) while subjects assumed the following postures: bilateral kneeling in full flexion, bilateral kneeling at 90° of flexion, kneeling on one knee, and squatting (performed with 48" simulated mine roof).

### Methods:

The forces, stresses, and moments at the knee were first statically evaluated for these postures. Muscle activity of the knee extensors and flexors was then evaluated while subjects lifted a block (25 lbs) from their right side, transferred it across their body, and placed it on the ground on their left side.

### Results:

The majority of the stress (>60%) was transmitted to the knee via the tibial tubercle with some transmitted via the inferior aspect of the patella. Kneepads reduced the peak pressure at the knee, but had little effect on the mean stress across the patella and tibial tubercle. The failure of current kneepad designs to reduce this stress may explain the high incidence of bursitis in these mines demonstrating a need for kneepads that better distribute these forces across a larger area.

The results suggest that squatting and kneeling on one knee be avoided as they result in higher muscle activity with squatting having high flexion and varus moments and kneeling on one knee having increased shear loading. Kneeling near full flexion required the least amount of muscle activity of the postures studied lending to decreased energy demands and making it likely to be the predominant posture used in these environments. Unfortunately, high joint flexion may pinch the posterior meniscus leading to meniscal tears. When kneeling near full flexion, a large amount of bodyweight is transmitted through the feet reducing the loading at the knee. It may be possible to design support devices that increase the load transmitted through the feet effectively reducing the flexion moment at the knee.

### Conclusion:

The results also indicated that kneeling near 90° flexion created the least hazardous loading condition and should be primarily utilized when in low working heights. Implementing postural rotation strategies with minimal usage of squatting and kneeling on one knee may decrease the detrimental effects of prolonged kneeling and squatting.

**Keywords:** Biomechanics, Postures, Physical exposure, Specific sectors



## EFFECT OF FOUR DIFFERENT GLOVES ON MAXIMAL GRIP FORCE OF SUGAR CANE CUTTERS

SILVÉRIO O.L., OLIVEIRA A.B.

Department of Physical Therapy, Federal University of São Carlos, São Carlos, Brazil.

### Aims:

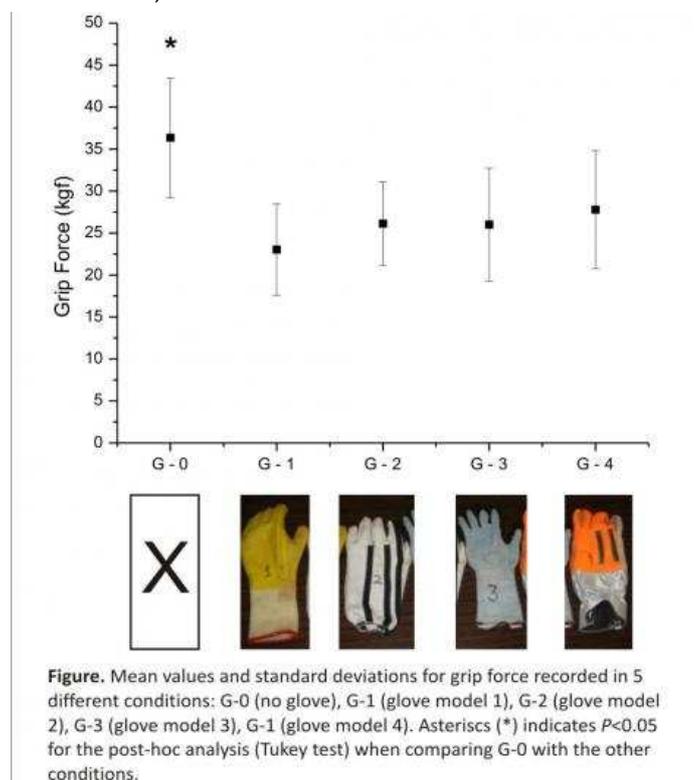
Evaluating the effect of four different gloves on grip force of sugar cane cutters.

### Methods:

Twenty-three right-handed subjects (74% of men), with no musculoskeletal symptom in upper limbs (according to the body map proposed by Corlett and Bishop, 1976), were randomly selected among 857 workers from a sugar and alcohol plant located in Sao Paulo State/Brazil. They were evaluated in seated position with the elbow at 90°, wrist and forearm at neutral position. Grip force was recorded using an analogical dynamometer. Two repetitions were performed as familiarization and the test was based on three repetitions – mean values were used as reference. Shapiro Wilk's and Levene's test were applied to evaluate normality and homogeneity, respectively. Data were compared through ANOVA one-way and Tukey test with alfa level at 0.05.

### Results:

All gloves caused a significant reduction in the grip force of sugar cane cutters (Figure). Despite the tested gloves had different designs and materials, there was no difference in the grip force produced when workers were wearing them. Gloves caused a mean reduction of 29.19% in the grip force (G-1: -36.6%; G-2: -28.11%; G-3: -28.47%; G-4: -23.56%).



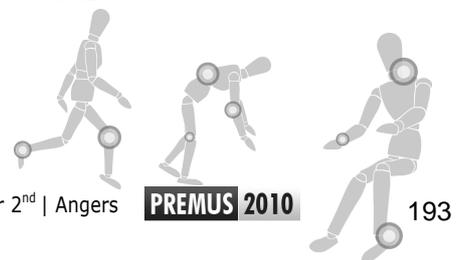
### Conclusion:

All gloves have reduced the maximal grip force, indicating that to generate the same power, forearm muscles have to produce a higher effort. Although different models of glove are available and specially designed for sugar cane cutters, they seem to have the same effect on grip force. Gloves are important to protect workers against mechanical risks as cuts produced by both the machete and sugar cane leafs, and still there is the need for a glove that causes a lower reduction in grip force in order to reduce musculoskeletal strain on upper limbs of sugar cane cutters.

**Keywords:** Biomechanics, Agriculture, Upper limb

### Reference:

Corlett EN, Bishop RP. A technique for assessing postural discomfort. *Ergonomics*. 1976;19:175-82.



## DEVELOPMENT OF LOW FREQUENCY FATIGUE IN LOW-LOAD REPETITIVE WRIST MOVEMENTS INVESTIGATED WITH A SERVO-CONTROLLED MOTOR SYSTEM

TURTURICI M., D'ERRICO A., PIERRO M., ROATTA S.

*Dept. Neuroscience, Physiology Div., University of Torino Medical School, Torino, Italy, Epidemiology Department, ASL TO3, Piedmont Region, Italy*

### Aims:

Low-load repetitive movements (LLRM) represent a risk factor for the development of upper limb musculo-skeletal disorders. The possible underlying pathophysiological mechanisms include over-activity of low-threshold motor units and mechanical (shear) stress over moving muscle fibers and ensuing recurrent inflammatory processes.

This work aims at disentangling the role of the different factors in the development of low-frequency fatigue (LFF) by investigating different working modalities: “active” (metabolic and mechanical stress), “passive” (only mechanical stress) and “isometric” (only metabolic stress).

### Methods:

A repetitive wrist flexo-extension task was performed in controlled laboratory conditions, based on a servo-controlled motor (Sensodrive, Wessling, DE). The motor can also be PC-driven so that it actually generates the oscillatory movement and let the subject passively follow or can be blocked so that the exercise is performed in isometric conditions.

In a first “active” experimental series 16 healthy subjects were asked to perform a paced wrist flexo-extension task ( $\pm 30$  deg amplitude, 1 Hz frequency, viscous load, peak load amplitude=10% MVC, 1 h duration: 10 repetitions of 5.5 min work + 30s duration for 1h). LFF was assessed by electrical stimulation of extensor muscles, before, during and after the working task. In a second “passive” series the subjects passively followed the same movement pattern. In this case the motor performed the actual movement while the muscles remained completely relaxed. Finally a third “isometric” series is planned in which the same pseudo-sinusoidal torque pattern of the “active” series will be achieved while the handle is blocked.

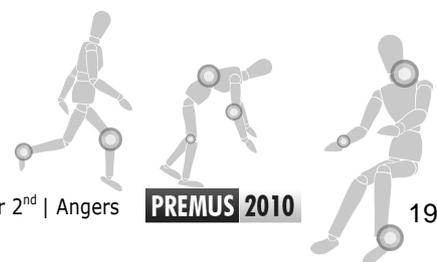
### Results:

The subjects perceived little or no fatigue after active task completion but the LFF index exhibited a consistent decrease already at 6 min after the beginning of the task ( $14.38 \pm 12.38\%$ ,  $P < 0.05$ ), by  $30.44 \pm 20.96\%$  ( $p < 0.05$ ) at the end of the task, and did not recover in the following 50 min. Preliminary results indicate that 5/7 subjects enrolled in the passive task also exhibit LFF (index decrease:  $-22.8 \pm 16.52\%$ , all subjects after the task).

### Conclusion:

Acute exposure to LLRM induces marked and long lasting changes in muscle function that can be non-invasively detected by LFF. Preliminary results from the passive task indicate that mechanical factors, in addition to metabolic factors, may affect the assessment of LFF. A more complete picture should be provided by the investigation of the isometric task in which muscle movement and shear forces are largely prevented.

**Keywords:** Biomechanics, muscle activity, upper limb



## SMALL INFLUENCE OF CHRONIC PAIN AND NO INFLUENCE OF MOOD ON VIBROTACTILE PERCEPTION THRESHOLDS AMONG WORKING WOMEN

SANDÉN H.<sup>1</sup>, GUNNAR WALLIN B.<sup>2</sup>, HAGBERG M.<sup>1</sup>

<sup>1</sup> Occupational and Environmental Medicine, Sahlgrenska School of Public Health and Community Medicine, University of Gothenburg, Sweden - <sup>2</sup> Institute of Neuroscience and Physiology, Sahlgrenska Academy, University of Gothenburg, Sweden

### Aims:

In chronic diffuse upper limb pain, absence of physical abnormalities is frequently stated. The aims of our study were to: (1) investigate the function of the somatosensory pathways and (2) investigate whether mood influences the result of vibration threshold testing.

### Methods:

Measurements of; (1) vibrotactile perception thresholds (VPTs) and nerve conduction in working women with (n=35) and without (n=65) chronic diffuse upper limb pain, and (2) perceived stress and energy using a two-dimensional mood adjective checklist.

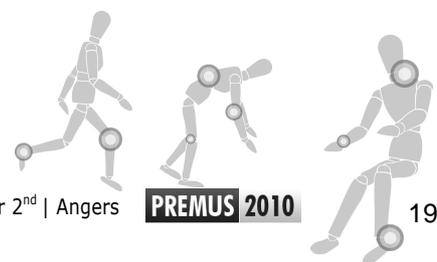
### Results:

The groups did not differ in any parameter of the nerve conduction measurements. Women with chronic pain demonstrated raised VPTs within the territories of the radial and ulnar nerves, but not within the territory of the median nerve. Neither perceived stress nor energy appeared to influence the VPT.

### Conclusion:

Increases of VPTs in chronic diffuse upper limb pain may be due to peripheral nerve affliction but our findings support the idea that increases of VPTs also may be secondary to the pain and may be brought about by a central nervous mechanism.

**Keywords:** Mechanism of pain and tissue injury, Computer work, Health care workers



## EVALUATION OF WRIST, FOREARM AND ELBOW RANGE OF MOTION DURING BOX HANDLING AT A REGULAR AND AN ERGONOMICALLY DESIGNED SUPPORT

SILVA L.C.C.B., OLIVEIRA A.B., ALEM M.E.R., GIL COURY H.J.C.

Physiotherapy Department, Federal University of São Carlos, São Carlos, SP, Brazil

### Aims:

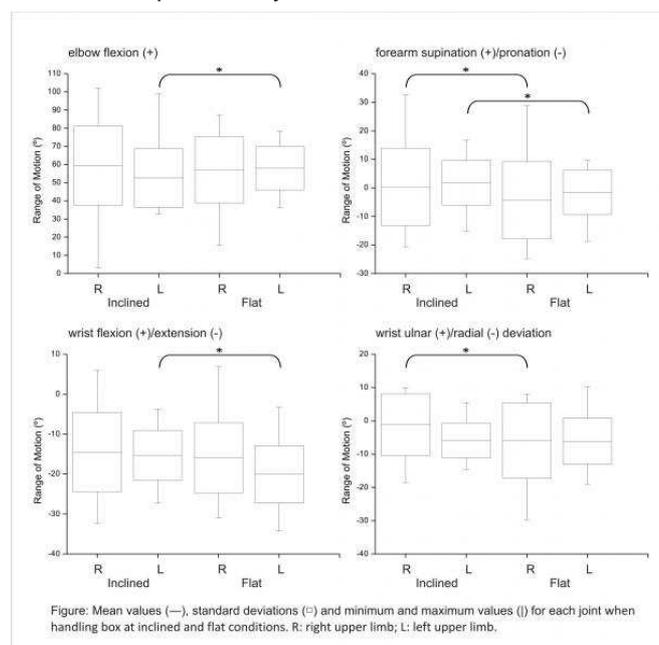
Inclined support or surfaces have been proposed as one of the possible intervention to reduce wrist amplitudes when grasping material or filling in boxes at industrial settings. However, inclined surfaces might also be a constraint for other activities occurring at the same working bench. Thus, the cost-benefit of such intervention should be expressive in order to justify its implementation. To compare postures of wrist, forearm and elbow when handling boxes at a regular (flat) and an ergonomically designed support (inclined).

### Methods:

Seven experienced workers handled cardboard boxes (dimensions: 53x47x27 cm, weight: 7 to 20 kg) with lateral cut-outs on all sides from a flat and inclined (330) support. Bilateral upper limbs movements were recorded at a real work conditions using biaxial electrogoniometers (EGM) and the DataLog acquisition unit (Biometrics, UK). The sampling frequency was set at 100Hz. Each worker performed four manual material handling. Tasks were videotaped and synchronized with the EGM recording. Data were analyzed through a MatLab routine. The Wilcoxon statistical test was applied ( $p \leq 0.05$ ) to compare mean motion values for each joint.

### Results:

Statistically significant differences between inclined and flat support were identified for flexion of left elbow, flexion/extension of left wrist, deviation of right wrist and pronation/supination of the forearms. The inclined support reduced extreme wrist values, particularly the radial deviation.



### Conclusion:

However, considering the mean values, the maximal differences between conditions were 5°. Thus, although the Wilcoxon test identified statistical differences between the mentioned conditions, the small differences between mean amplitudes suggest that the inclined support did not improve the postures substantially. Further studies, involving different grasping angles and shoulder evaluation, should be developed to elucidate the possible benefit of this intervention on handling upper limb movements.

**Keywords:** Biomechanics, Postures, Physical exposure, Upper limb



## ELECTRICAL ASSISTED BICYCLE FOR POSTMEN: CONSEQUENCES ON PHYSIOLOGICAL RESPONSES AND COGNITIVE PERFORMANCES.

THEUREL J., THEUREL A., LEPERS R.

*INSERM U887, Faculty of Sport Science, University of Burgundy, Dijon, France.*

### Aims:

Cycling postmen at work performed both physical activities (mail delivery) and cognitive tasks (mail sorting). In order to reduce workload, and to prevent work injury, La Poste has recently experimented the use of electrical assisted bicycle (EB) for postmen during mail delivery. However, it has also been shown that intensive prolonged work, such as cycling exercise, could also affect cognitive functions (Tomprowski, 2003). In this context, the aim of the present study was twofold: 1) to compare physiological responses during cycling exercise performed with EB, versus classical bicycle (CB), 2) to analyze the cognitive performances after prolonged cycling with EB versus CB.

### Methods:

Ten subjects performed two identical prolonged intermittent cycling exercises with EB vs. CB. In order to simulate cycling part of postal work (Theurel et al., 2008), the exercise sessions consisted of alternating cycling start phase (10 s) and recovery period (20 s), during 30 min. Cognitive performances were evaluated by a mail sorting test, at rest, and after each cycling session.

### Results:

During intermittent exercise, averaged oxygen uptake and heart rate were significantly ( $p < 0.05$ ) greater when cycling was performed with CB compared to EB. During start phases, the EMG root mean square (RMS) of the leg extensor muscles were also significantly ( $p < 0.001$ ) greater with CB than with EB. The rate of perceived exertion during exercise was, on average, significantly ( $P < 0.001$ ) greater with CB than with EB exercise. The time to mail sorting was similar at rest and after EB exercise but increased by  $13 \pm 16\%$  after CB cycling.

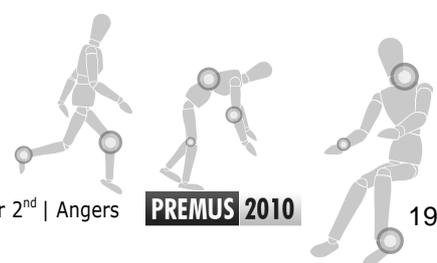
### Conclusion:

This study evidenced that the use of EB during intermittent cycling exercise significantly reduces muscular tension compared to CB. Indeed, a significant dependence has been demonstrated between force level and EMG amplitude during cycling (Sarre et al. 2003), suggesting that muscle force was greater when cycling with CB. Muscular strains, being a potential cause for the occurrence of musculo-skeletal disorders (MSD), the daily use of EB could preserve the long term health of postal agents. The present data also showed that the use of EB during intermittent cycling exercise could preserve mail sorting performance, which could improve the work effectiveness of postal agents. These findings could mainly be explained by the decrease of physiological demand when subject cycling with EB. More generally, in the current social context, electrical assistance could facilitate the use of bicycle during urban travel.

**Keywords:** Muscle activity, Early prevention, Lower limb.

### References:

- Sarre, G., Lepers, R., Maffioletti, N.A., Millet, G. and Martin, A. 2003. Influence of cycling cadence on neuromuscular activity of the knee extensors in humans. *Eur J Appl Physiol*, 88 (4-5), 476-9.  
 Theurel, J., Offret, M., Gorgeon, C. and Lepers, R., 2008. Physiological stress monitoring of postmen at work. *Work*, 31(2) 229-36  
 Tomporowski, P.D., 2003. Effects of acute bouts of exercise on cognition. *Acta Physiol (Amst)*, 112 (3), 297-324.



## **NORMALIZATION TECHNIQUES USED IN ELECTROMYOGRAPHIC EVALUATIONS OF ERGONOMIC INTERVENTIONS**

WALLACE W.N., ROSECRANCE J.C., DOUPHRATE D.I.

*Colorado State University, Fort Collins, CO, USA*

### **Aims:**

There are several methods of normalizing EMG to assess ergonomic interventions. Maximal voluntary contractions (MVC) are the most widely used method, though reference, force equivalent, or ramped contractions are also common. Comparing results between studies is complicated by the use of a variety of methods to normalize data. The present study assessed the different EMG normalization techniques on sensitivity, specificity, and correlation to external forces.

### **Methods:**

Males and females of varying physical dimensions were recruited to represent a range of hand sizes and strength. Age, hand dominance, functional hand grip dimensions, and maximum grip strength were recorded for each participant. Functional hand grip dimension was recorded as the distance between the DIP joint of the third finger and the IP joint of the thumb. Grip strength was assessed using a Jamar dynamometer at the third width setting which was most similar to mid closure on the hand tool used to perform the task in the study. Participants performed 10 closures (defined as fully open to complete closure of the snips) cutting 26 gauge galvanized steel sheet metal. The cutting task was alternated with a recreation of the force using a dynamometer recorded with the EMG system. EMG of the finger flexors and finger extensors in the forearm were used to assess muscle activity as an estimate of force output during each trial. The root mean square (RMS) of the EMG output was calculated with a moving window of 100 mSec for evaluation and comparison with the normalization values. Normalization techniques included four reference contractions at 5, 10, 15, and 20 kg, pre-trial MVC, post-trial MVC, and a ramped contraction. The reference contractions provided values with which to calculate a regression equation to determine force equivalent units. The ramped contraction performed with the integral dynamometer was also used to determine force equivalent units.

### **Results:**

Initial results suggest MVC normalization is the least sensitive technique with only a moderate relationship between RMS EMG values and external forces. RFE normalization is the more specific, with a correlation to external forces similar to the MVC. A ramped contraction will yield the greatest correlation between RMS EMG and force. Finally,

### **Conclusion:**

The results of this study will be presented and implications discussed. Information gained from this study provides insight into the challenges of EMG normalization techniques in ergonomic research.

**Keywords:** Muscle activity, exposure measurement methods, intervention studies



**EFFECT OF LIFTING CONDITION ON THE BOX TRAJECTORY VARIABILITY**

YOON J.

*Occupational and Industrial Orthopaedic Center (OIOC) NYU Hospital for Joint Diseases, New York, NY USA***Aims:**

The performance of successive lifting trials under a given lifting condition was assumed to be similar in the biomechanical demand. Because most of industrial lifting injuries occur below worker's maximal lifting capacity, the performance variability during lifting should be explored. Even in the lifting a given weight from an identical origin to a destination, there are many possible trajectories of the box and there is very limited studies how the optimal trajectory is selected. The aim of this study is to analyze how the lifting pace, box weight and target size influence the lifting trajectory.

**Methods:**

Thirty nine (19 females) healthy subjects performed a total of 24 lifts (3 lifting trials of 2 lifting paces, 2 box weights, and 2 target sizes) from waist to shoulder level. Kinematical data of the box and upper extremity were collected. The distance between the peak vertical box location and the level of target was calculated for the vertical overshoot. The peak and mean deviations (the perpendicular distance) of the trajectory from the virtual straight line between the origin and the destination of lifting were computed. Repeated measures multivariate analysis of variance performed

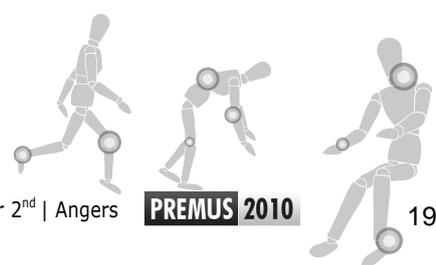
**Results:**

The vertical overshoot and trajectory deviation were significantly decreased at maximal pace and there was no effect by weight. The effect of target size was different by lifting pace. The larger target size increased the vertical overshoot and trajectory deviation at the preferred lifting pace and the larger target size decreased at the maximal pace. The larger target size increased the inter-trial vertical overshoot variability at the preferred lifting pace and the larger target size decreased at the maximal pace. The peak trajectory deviation variability was greater at the preferred lifting pace. There was no systemic effect on the mean trajectory deviation.

**Conclusion:**

The lifting trajectory is altered its magnitude and variability at different lifting pace according to the priority of performance and the most effective strategy was selected to achieve the task goal. At the preferred lifting pace, the lifting strategy which minimizes the distance between the body and the box was selected, while minimizing the trajectory deviation from the virtual straight line seems to be the priority at the maximal lifting pace. The biomechanical demand of different lifting trajectories should be analyzed further because the biomechanics are not considered when selecting the optimal lifting strategy. These findings underscore the lifting trajectory as a source of lifting performance variability.

**Keywords:** Biomechanics, postures, physical exposure, personal risk factors for MSD



## EXPOSURE MEASUREMENT METHODS

### LONG PERIODS WITH SUSTAINED TRAPEZIUS MUSCLE ACTIVITY AND NECK PAIN

ØSTENSVIK T., VEIERSTED K.B.

Norwegian Forest and Landscape Institute, Ås, Norway, National Institute of Occupational Health, Oslo, Norway

#### Aims:

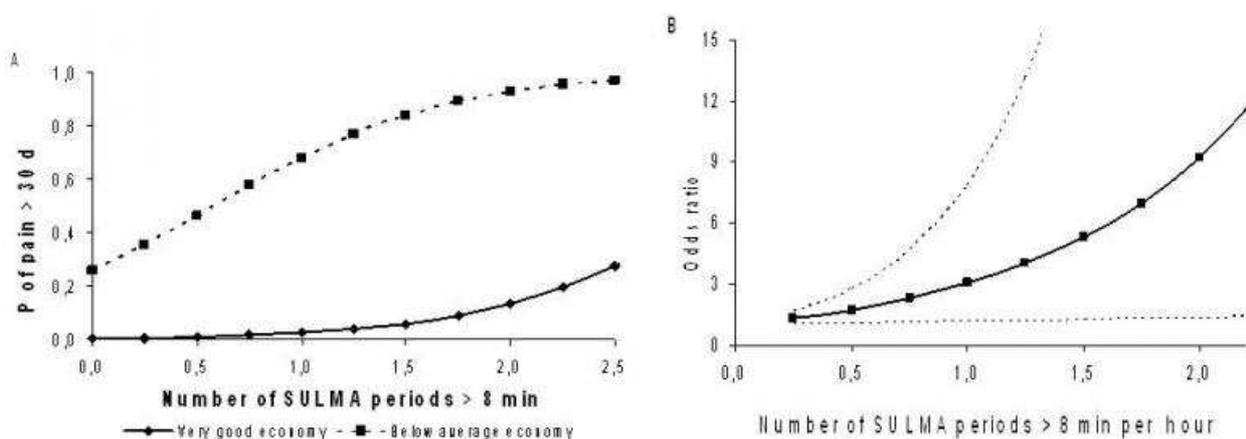
In many occupations the neck muscles are exposed to light loads that demand low-level force exertions and posture control that may be deleterious to the muscle. The number of periods with 'sustained low-level muscle activity' (SULMA, defined as activity >0.5% EMGmax) for >10 min duration in the right upper trapezius (RUT) muscle, has previously been associated to simultaneously reported neck pain [1]. The aim of this follow-up study was to evaluate the effect of this work pattern on neck pain after one year.

#### Methods:

Two groups of forest machine operators driving harvesters or forwarders (n=19, 20) and researchers (20) working respectively with control levers in the cabin and PC in the office, were investigated. EMG recorded the activity in the RUT muscle during one working day. The number of SULMA periods of 1.6 s duration or longer were calculated in predetermined intervals: 1.6-5 s, 5-10, --- 8-10 min, 10-20 and >20. Neck pain was assessed by the 'Standardised Nordic Questionnaire' (SNQ) dichotomized into pain for more or less than 30 days last year. A logistic regression model was used to express long duration (>30 d) of pain as a function of different exposures and confounding factors.

#### Results:

The variables 'SULMA >8 min per hour' and 'personal economy' were significant. The probability of experience long duration of pain was markedly higher for persons with 'below average economy' compared to those with a 'very good economy' (Figure, panel A). 'SULMA >8 min per hour' at baseline revealed an OR of 3 for neck pain >30 days (Figure, panel B) [2].



**Figure A:** Probability of having pain in the right neck for >30 d after one year as a function of number of SULMA periods per hour in the RUT muscle at baseline for persons classified with perceived personal economy as above or below average, in three occupational groups (N = 45), equation:  $p = e^{(-7.700 + 1.808 * \text{SULMA} > 8 \text{ min} + 2.217)}$  **B:** OR of neck pain >30 d compared to ≤30 d SNQ as a function of the number of 'SULMA periods >8 min per hour' at baseline. The 95% CI (broken lines) equation:  $p = e^{(-2.448 + 1.112 * \text{SULMA} > 8 \text{ min})}$

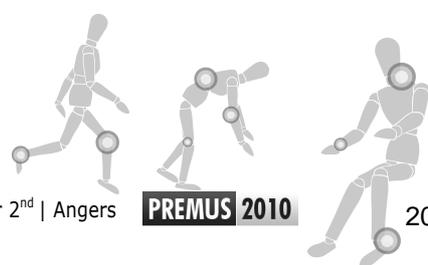
#### Conclusion:

This method could be used in work load assessment in search of muscle activity pattern that may increase the risk for muscle pain.

**Keywords:** Muscle activity, Exposure measurement methods, Epidemiology

#### References:

- [1] Østensvik T, Veiersted K.B., Nilsen P. A method to quantify frequency and duration of sustained low-level muscle activity as a risk factor for musculoskeletal discomfort. JEK, 2009;19:283-294.
- [2] Østensvik T, Veiersted K.B., Nilsen P. Association between numbers of long periods with sustained low-level trapezius muscle activity and neck pain. Ergonomics, 2009;52:12:1556-1567.



## RELATIONS BETWEEN WORK STRAIN RECORDING METHODS AND CLINICAL OUTCOMES OF WRULMSDS

MEYER J.P., TURPIN-LEGENDRE E., DIDRY G.

INRS, France

### Aims:

Relate upper limb musculoskeletal disorders (uIMSD) to the worker's functional capacities and occupational constraints which are evaluated by means of different tools in the actual working situation.

### Methods:

Maximal voluntary isometric forces at shoulder, elbow and wrist level and cardiopulmonary fitness (step-test) were measured on 90 women in 3 companies. The uIMSD levels were quantified during a clinical examination and answers to pain and psychosocial questionnaires. The evaluation of occupational biomechanical stress was conducted by objective methods (EMG and goniometers), 2 methods of task observations and a subjective evaluation (Borg CF-10 scale) of local load at 7 anatomical locations of the whole body. These methods were applied at regular intervals during the whole work day.

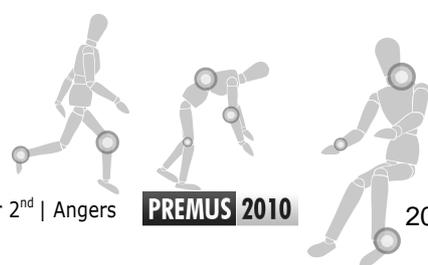
### Results:

In these tasks at high risks of uIMSD, 3 out of 4 women complain and these complains are related to age ( $p < .001$ ), work subjective difficulty ( $p < .001$ ) and freedom to take pauses ( $p < .02$ ). The results show also that: i) uIMSD are different from one factory to the other and that these differences are explained partially by a gross activity definition, ii) the functional characteristics (strength and fitness) of the employees are poorly related to their uIMSD, iii) simple methods of task observation are able to classify the constraints difficulty as well as objective methods, iv) these simple methods are well adapted for detecting the body areas most affected by uIMSDs and, v) when subjective (CR-10) evaluation is asked to an acceptable number of subjects their information is of prime interest. Indeed, fatigue and uIMSD locations are well predicted by these scales. In our study the women with the highest strength levels suffer rather more uIMSD than their less strength colleagues.

### Conclusion:

Our study shows that, in risky strain situations, individual characteristics as well physical as psychological, do not explain most of the observed uIMSD. A simple tool of occupational task description is able to demonstrate that tasks place workers at high risk of uIMSD and thus could convince employers and employees to engage a preventive action. The work activity observation used alone does not allow a detailed analysis of biomechanical constraints. But, in our study, when it was combined with the subjective evaluation made by the workers, it is a more efficient tool as biomechanical recordings to identify the anatomical areas of the upper limb the most at risk of MSDs.

**Keywords:** Exposure measurement methods, Personal risk factors for MSD, Upper limb



## DESIGNING A METHODOLOGY OF CAPTURING AND ASSESSING WORK-RELATED RISK FACTORS FOR THE CARPAL TUNNEL SYNDROME (CTS)

HOEHNE-HUECKSTAEDT U.M., ELLEGAST R.P.

IFA - Institute for Occupational Safety and Health of the German Social Accident Insurance, Sankt Augustin, Germany

### Aims:

Highly repetitive activities are known as risk factors for a lot of work-related disorders of the upper limb, among these the carpal-tunnel-syndrome (CTS). There are numerous risk assessment methods concerning repetitive tasks, however, none is particularly designed for CTS. Thus, the aim of this work was to find parameters for CTS-specific, work-related risk factors and to evaluate them in exemplary field measurements.

### Methods:

In accordance to the well-known, relevant literature, risk factors for CTS were qualitatively defined. A further literature search was carried out in databases like Medline, Embase, and TEMA; the search terms, for example angular velocity, angular acceleration, or grip force, focused on measuring methodology in order to find objective parameters for those risk factors. Among a first selected sample of about 40 articles only thirteen deliver the explicit facts looked for; nevertheless, parameters were detected and proved for application. Therefore, examinations of several work places and different repetitive tasks were performed using the CUELA measuring system [1] for posture capturing.

### Results:

Repetitive tasks that might provoke CTS are characterised as follows: Repetitive wrist movements, i.e. flexion and extension, high hand force and hand-arm-vibrations. Each of these factors alone can affect the wrist while the combination of them augments the risk. In order to measure repetitiveness, mean power frequency of wrist movements are evaluated as an appropriate mean. The work load arising from flexion and extension of the wrist can quantitatively be described by the angular distribution, the mean angular velocity, and the frequency of short pauses with an angular velocity  $< 1^\circ/s$  for continuous time periods of at least 0,5 s [2]. After adequate processing and analysis, these parameters could successfully be generated from measurement data registered with the measuring system CUELA. For estimation of the applied hand forces, electromyography (EMG) measuring strategies and the "force matching"-method seem to be feasible, semi-quantitative methodologies [3] that, to some extent, can be implemented into the CUELA measurement setting or performed supplementary.

### Conclusion:

In the literature research quantified and consistent parameters of risk factors for CTS could be identified; the study also shows that the measuring system CUELA can be adapted to acquire these parameters, albeit the measurement strategies are to be refined. This is the necessary first step on the way to build up a database of valid measures for CTS risk factors and finally to deduce assessment criteria.

**Keywords:** Postures, physical exposure, Exposure measurement methods, Carpal tunnel syndrome

### References:

- [1] Ellegast, RP, Hermanns I, Schiefer C. Workload Assessment in Field Using the Ambulatory CUELA System. In: Duffy, V.G., editor. Digital Human Modeling HCII. 2009, Springer, Berlin 2009: 221-26.
- [2] Hansson, G. Å., Balogh, I; Ohlsson, K. et al. Physical workload in various types of work: Part I. Wrist and forearm. Int J Ind Ergon. 2009; 39: 221-33.
- [3] Bao, S. & Silverstein, B. Estimation of hand force in ergonomic job evaluations. Ergonomics 2005; 48(3): 288-301.



## VARIABILITY OF OBSERVED UPPER EXTREMITY PHYSICAL EXPOSURES AMONG DIFFERENT JOB TYPES

DALE A.M., JAEGER L.A., EVANOFF B.

Division of General Medical Sciences, Washington University School of Medicine, St. Louis, Missouri, USA - Interventions LLC, Defiance, Missouri, USA

### Aims:

To evaluate the within and between worker variability of upper extremity physical exposures among different job types.

### Methods:

We enrolled 1107 newly-hired workers from several industries into a longitudinal study evaluating upper extremity health outcomes and associated personal and work exposures. A subset of workers (n=133) that remained employed in the same job received worksite visits at two points in time. Job information and videotaped samples of workers performing work tasks were used to rate physical exposures of repetition and force for several tasks on a 0 to 10 point scale and to rate average daily time spent in other work exposures (lifting/carrying, hand gripping, finger pinching, and wrist bending) using a 7 point scale. We explored the variability of work exposures within workers and between job types using t-tests and ANOVA.

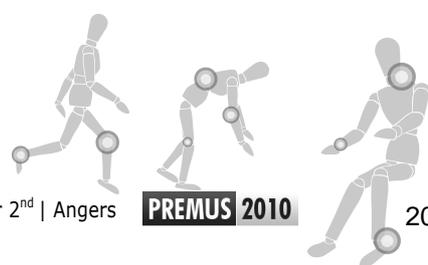
### Results:

Subjects worked in 10 different job types: engineer (n=7), construction carpenter (n=22), housekeeper (n=23), floor installer (n=12), radiology technician (n=10), laboratory worker (n=12), pharmacy technician (n=6), clerical worker (n=9), sheet metal worker (n=20), surgical instruments processor (n=7), and surgical technician (n=5). Analysis of variability of exposures across all work types showed significant differences of mean exposures between jobs ( $p < 0.05$ ). Examining exposure variability of workers from two time points within each work type separately showed similar mean worker exposures in most work types (8/10). For two work types (construction carpenters and surgical technicians), the within worker variability was greater than the between worker variability for most physical exposures (within worker Sum of Squares > between worker Sum of Squares). Paired worker exposures from two time points showed significant differences for some exposures in construction carpenters, housekeepers, clerical workers, and sheet metal workers ( $p < 0.05$ ).

### Conclusion:

We found that exposures of workers within the same job were similar, while exposure levels differed between different jobs. Observed physical exposures obtained from two time points thus produced homogeneous exposure groups within job types, and could be used to estimate exposures of individual workers. Some work types may require additional samplings of individual workers over time to improve the precision of exposure estimates.

**Keywords:** Exposure measurement methods, Epidemiology, Upper limb



## OPERATIONAL VALIDITY OF CAPTMS DESIGN TOOL FOR ASSESSING MUSCULOSKELETAL DISORDER RISK

ATAIN KOUADIO J.J., AUBLET-CUVELIER A., CLAUDON L., MOCHEL J.L., MUTH D.

*Institut National de Recherche et de Sécurité (INRS), Département Homme au travail, 54519 Vandoeuvre cedex, France.*

### Aims:

The prevention department at CRAM Alsace-Moselle [regional health insurance fund] has developed the CAPTMS tool, which is intended for work activity designers, in particular methods engineers. CAPTMS integrates the risk assessment principles of the OCRA method [1] and is aimed at taking into account prevention of upper limb musculoskeletal disorders (ULMSD) right from design stage. At the request of CRAM Alsace-Moselle, INRS has conducted a study of designers having already received training for this tool. The aims of this study were to characterise CAPTMS usage, assess its relevance and clarify its position in the range of ULMSD prevention aids.

### Methods:

Analysis of CAPTMS implementation by designers was based on the Leplat theoretical model of activity analysis [2], which considers interactions that govern globally a work activity. The real work activity was characterised by taking into account the determining factors acting on it, as well as the resulting real or potential effects. The study featured structured interviews with trained users and beneficiaries of the tool, complemented by direct observations of CAPTMS usage at companies.

### Results:

The CAPTMS tool allows designers to consider methodically work situation design/re-design phases in relation to MSD risk. It leads them to refine their representation of projected future work situations by extending the conventionally technical design approach towards an approach more widely integrating man's place in future work design. Using CAPTMS contributes to developing solid conversion proposals to reduce the risk coefficient given by the tool. These proposals are of technical and organisational order. On the other hand, the results show that CAPTMS is especially implemented to improve a work situation during analysis of existing conditions and not upstream, when designing new work situations. Potential work situation variability and inclusion of the future operator in the design process are not sufficiently considered by CAPTMS users. Interpretation of CAPTMS-based results varies, depending on user expectations, ergonomics knowledge and MSD risk representation.

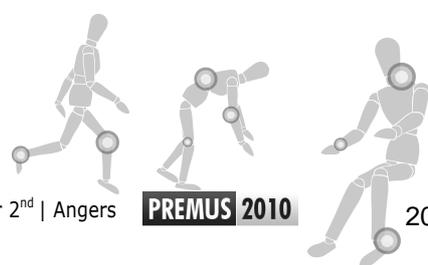
### Conclusion:

The results of this study provide data for reflection on the advantage of and conditions involved in contributing knowledge, skills and tools aimed at design players for the purpose of integrating MSD risk at design stage.

**Keywords:** Postures, physical exposure, exposure measurement methods, early prevention

### References:

- [1] Occhipinti E. - OCRA: A concise index for the assessment of exposure to repetitive movements of upper limbs, *Ergonomics* 1998; 41(9): 1290-1311.,
- [2] Leplat J. - *L'analyse psychologique de l'activité en ergonomie : aperçu sur son évolution, ses modèles et ses méthodes*, Editions Octares, 2000, Toulouse. 162p.



## A RISK INDEX FOCUSING THE TIME PATTERN OF WORK AND RECOVERY

FORSMAN M., TOOMINGAS A., VEIERSTED K.B., MATHIASSEN S.E.

Department of Public Health Sciences and Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Centre for Musculoskeletal Research, University of Gävle, Sweden - National Institute of Occupational Health, Oslo, Norway

### Aims:

Musculoskeletal disorders are common in occupations characterized by prolonged periods of work with insufficient recovery. A general lack of short muscle rest periods (Veiersted et al., 1993), as well as the number of trapezius muscle activity periods longer than 8 minutes above 0.5% EMGmax (Østensvik et al. 2009) have shown an association with pain. Both results can be explained by the Cinderella hypothesis: low-threshold motor units are at risk for selective overuse. So far, muscle rest and exposure variation have been assessed mostly by workday averages. In this study, we developed a method for analyzing long periods, reflecting the effect of insufficient recovery.

### Methods:

The model assumes that disorder risk will increase when an exposure continues beyond a predefined duration, e.g. one hour of uninterrupted seated work (uphill in figure). The risk index is the accumulated time at risk (flat top parts). In order to counteract the risk, exposure must change into "recovery" e.g. standing or walking (downhill in figure). After a duration of recovery, e.g. 5 minutes of standing/walking, the maximum effect has been obtained (flat bottom). To explore the model, data were available on gross body postures (n=140) and EMG (n=40) from different occupations. For EMG, recovery was considered present at a level below 0.5%max, and a minimum of 2 minutes of recovery was required for 10 minutes of work.

### Results:

The figure shows the model exemplified by a pattern of gross body posture. The risk index in this case is 24%time.

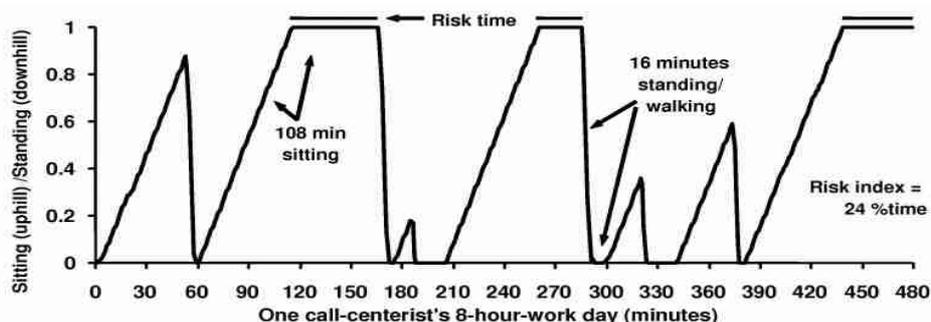


Figure. An illustrative example of gross body posture. Risk time (horizontal lines on top) is present when less than 5 min have been spent standing/walking during the previous hour (1 h continuous sitting is normalized to 1).

### Conclusion:

The basic idea of combining continuous data on work and rest may be used in future studies relating patterns of biomechanical exposure to pain. The rise and fall parts may be based on non-linear functions; recovery could e.g. be exponential (Krajcarski and Wells, 2008).

**Keywords:** Muscle activity, postures, physical exposure, exposure measurement methods

### References:

- Krajcarski S, Wells R. The time variation pattern of mechanical exposure and the reporting of low back pain. *Theoretical Issues in Ergonomics Science*. 2008; 9:45–71.
- Østensvik T, Veiersted KB, Niilen P. Association between numbers of long periods with sustained low-level trapezius muscle activity and neck pain. *Ergonomics*. 2009;52:1556-1567.
- Veiersted KB, Westgaard RH, Andersen P. Electromyographic evaluation of muscular work pattern as a predictor of trapezius myalgia. *Scand J Work Environ Health*. 1993;19:284-90.



## COST-EFFICIENCY OF ADDING ANOTHER SUBJECT OR ANOTHER DAY TO AN EXPOSURE DATA SET

MATHIASSEN S.E., TRASK C.M.

Centre for Musculoskeletal Research, University of Gavle, Sweden

### Aims:

Some studies investigate statistical efficiency in occupational exposure assessment [1], but few consider the associated costs [3]. Tradeoffs exist in identifying a cost-efficient alternative for adding measurements to a dataset. This simulation study compared cost-efficiency for two such alternatives: recruiting one more subject or adding another day for an existing subject.

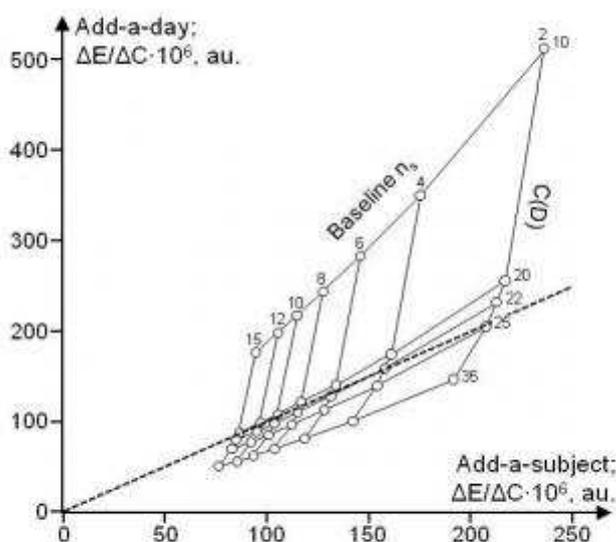
### Methods:

Multiple virtual data sets were created, differing in number of subjects, all monitored for one day, and in between-subjects and between-days exposure variabilities. Unit costs of recruiting a subject,  $C(S)$ , and collecting a measurement day,  $C(D)$ , were also varied over a wide range. For all datasets, efficiency was assessed as the inverse of the SEM [2], and total cost was calculated using a linear, two-level model (cf. [3]). Both described alternatives for adding data were then assessed with respect to their efficiency gains per monetary unit, i.e. incremental efficiency,  $\Delta E$ , divided by the corresponding cost,  $\Delta C$ .

### Results:

The add-a-subject alternative always showed the largest  $\Delta E$ . It was still superior when  $C(S)$  was low compared to  $C(D)$ , unless between-days exposure variability was extremely large. With large  $C(S)$ , the add-a-subject alternative was also preferable if between-days variability was small.

Figure 1 illustrates incremental cost-efficiency when low  $C(D)$  occurred together with large between-days exposure variability. Trade-offs between the two alternatives change with the size of the baseline dataset; small changes in  $C(D)$  shift the balance between alternatives.



Circles show values of  $\Delta E/\Delta C$  for 2-15 subjects,  $n_2$  in the baseline data set, as marked by "vertical" connection lines, combined with costs for measurement days,  $C(D)$ , varying between 10 and 35 as marked by "horizontal" connections. The dashed line indicates identical performance of the two alternatives. Exposure variance between subjects and between days: 100 and 50, respectively;  $C(S)$ :100.

Figure 1. Incremental cost-efficiency of the add-a-day and add-a-subject alternatives for increasing a data set.

### Conclusion:

Incremental cost-efficiency is a valuable tool for analyzing how to get the most information for available funds, or required information at the lowest cost. This study shows how a statistically trivial design question can have an intricate answer if costs are also considered.

**Keywords:** Postures, physical exposure, Exposure measurement methods, Methods in epidemiology.

### References:

- Mathiassen SE, Burdorf A, van der Beek AJ. Statistical power and measurement allocation in ergonomic intervention studies assessing upper trapezius EMG amplitude. A case study of assembly work. *J Electromyogr Kinesiol* 2002;12:27-39.
- Samuels SJ, Lemasters GK, Carson A. Statistical methods for describing occupational exposure measurements. *Am Ind Hyg Assoc J* 1985;46:427-433.
- Whitmore RW, Pellizzari WD, Zelon HS, Michael LC, Quakenboss JJ. Cost/variance optimization for human exposure assessment studies. *J Expo Anal Environ Epidemiol* 2005;15:464-472.



## THE EFFECT OF SAMPLING STRATEGY ON THE ACCURACY AND PRECISION OF VARIANCE COMPONENT ESTIMATES

LIV P., MATHIASSEN S.E.

Centre for musculoskeletal research, University of Gävle, Sweden

### Aims:

Variance components of exposure data are important information when designing an exposure assessment strategy. They have also been suggested as measures of variation in work. However, little research has concerned how to design an optimal measurement strategy for the purpose of retrieving precise variance components with minimum bias. The aim of the present study was to investigate precision and bias in estimations of variance components, when using different strategies for sampling data on upper arm elevation.

### Methods:

Data consisted of minute-by-minute values of percentage of time spent with an arm elevation above 90° for 23 car mechanics, each measured for four whole days. The investigated strategies all consisted in simulated sampling of 60 minutes of data from each of two working days in 10 subjects. Three different ways of allocating the sample within working days were employed: randomly distributed sampling periods of one, 15 or 60 minutes. On the basis of bootstrap simulations of each sampling strategy, bias and 90% prediction intervals were determined for estimations of the between-subjects, between-days and within-days exposure variance.

### Results:

When using sampling periods of one minute, the estimated variance components showed no or very small bias (table). For sampling periods 15 and 60 minutes, the within-day variance was biased downwards, while the between-days variance was biased upwards. Between-subject variances had only small bias. The widths of the predictions intervals increased when using larger sampling periods.

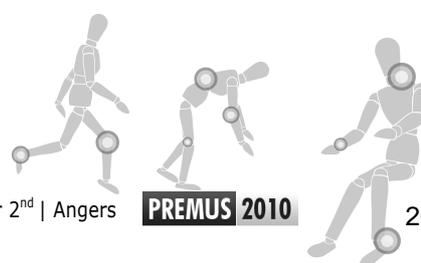
**Table.** Bias and prediction intervals for the three investigated sampling strategies. pred, prediction interval; L, duration of sample periods;  $s^2_{bs}$ ,  $s^2_{bd}$ ,  $s^2_{wd}$ , between-subject, between-days and within-days variance; bias, mean deviation from the variance components of the full data set ( $s^2_{bs} = 3.0$ ,  $s^2_{bd} = 4.0$ ,  $s^2_{wd} = 164.7$ ).

	L=1			L=15			L=60		
	$s^2_{bs}$	$s^2_{bd}$	$s^2_{wd}$	$s^2_{bs}$	$s^2_{bd}$	$s^2_{wd}$	$s^2_{bs}$	$s^2_{bd}$	$s^2_{wd}$
<b>bias</b>	0.0	-0.2	0.1	0.8	8.2	-8.8	1.6	17.2	-13.0
<b>pred</b>	[1.6,49.6]	[0.9,20.3]	[197.4,276.7]	[0.0,56.6]	[6.0,43.2]	[172.7,277.0]	[0.0,59.7]	[10.0,67.3]	[160.7,274.9]

### Conclusion:

Sampling in long continuous periods led to autocorrelation within the sample. This violation of the assumption of independent observations led to biased variance components. The prediction intervals indicated a considerable uncertainty when estimating variance components using the investigated strategies.

**Keywords:** Postures, Physical exposure, Exposure measurement methods, Methods in epidemiology



## AN INDEX OF PHYSICAL WORKLOAD TO EVALUATE AN ERGONOMICS PROGRAM IN NURSING HOMES

KUROWSKI A., BUCHHOLZ B., PUNNETT L.

*Dept. of Work Environment, Univ. Massachusetts Lowell, USA*

### Aims:

Musculoskeletal disorders have been associated with physical work demands of manual resident handling by nursing assistants in nursing homes. In 2005, a large nursing home corporation implemented a “No-Lift Program” (NLP) involving installation of resident handling equipment plus procedures for staff training and equipment maintenance. We evaluated the program’s effect on combined biomechanical load resulting from exposures such as lifting and non-neutral body postures. Hollmann et al.(1) developed an index of physical workload using employee self-reported frequencies of postures and manual handling activities, weighted by a weighting factor which is the difference between the standard compressive force on the L5-S1 vertebra and the compressive force estimated for a given posture. We adapted this index to our observational data and used it to compute the net biomechanical change in load on the lumbar spine.

### Methods:

Ergonomic exposures of clinical nursing staff in seven nursing homes were observed by trained ergonomists at baseline, 3-month, 12-month, and 24-month follow-up. We used the PATH(2) method, modified to add resident handling activities and specific types of equipment. An index of physical workload for nursing tasks was computed using the frequencies of PATH variables for trunk, arm, and leg postures and manual handling as exposure scores. The University of Michigan’s 3D Static Strength Prediction Program was used to calculate weighting factors for each exposure. The products of these two inputs were summed for an overall score.

### Results:

Thus far preliminary scores for the index of physical workload have been calculated using trunk and arm postures. Additional scores for manual handling will be computed. Results from our observational data showed that loads heavier than 50 pounds were handled less frequently and loads lighter than 10 pounds more frequently, after two years. The results indicated baseline higher scores for nursing assistants than Licensed Practical Nurses, as expected. Nursing assistants’ preliminary index scores decreased over the four time periods, both overall and specifically within resident handling.

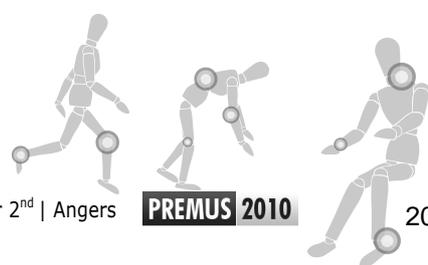
### Conclusion:

The index of physical workload allows for examining the combined biomechanical effects of multiple ergonomic exposures. Based on these preliminary findings, the workload index shows a reduction of physical exposures following NLP implementation. The observed reduction in heavy lifting suggests that the addition of the remaining index inputs will continue to show improved index scores for nursing assistants.

**Keywords:** Biomechanics, Exposure measurement methods, Intervention studies

### References:

Hollman, S., Klimmer F., et al. 1999. *Scandinavian Journal Work Environment Health* 25(2): 105-114.  
Buchholz, B., Paquet, V., et al. 1996. *Applied Ergonomics*, 27:177-187.



## A COMPARISON BETWEEN WORKSITE WALKTHROUGH ASSESSMENTS AND SELF-REPORTED MUSCULOSKELETAL EXPOSURE AND SYMPTOMS

SEMBAJWE G., QUINN M., KRIEBEL D., STODDARD A., BARBEAU E.

Department of Society, Human Development and Health, Harvard School of Public Health, Boston, Massachusetts, USA

### Aims:

Often in exposure assessment for epidemiology, there are no highly accurate exposure data to reference as a gold standard. The objective of this study was to assess exposure method agreement and examine associations between self-reported musculoskeletal outcomes and workplace exposures measured at the individual (self-reports) and job levels (walkthrough assessment).

### Methods:

Study participants came from a cohort of 1282 unionized workers from 14 worksites in 4 industries [Barbeau, et al. 2007, Quinn, et al. 2007, Sembajwe G, et al. 2010]. An audio computer-assisted self-interviewing system (ACASI) was used to deliver the questionnaire to study participants. Up to three occupational hygienists conducted extensive worksite walkthrough assessments and constructed a job exposure matrix (JEM). These individual worker survey responses and occupational hygiene walkthrough assessments were used to collect musculoskeletal exposure information (heavy lifting, awkward back, shoulder, and neck positions) and musculoskeletal symptom information (shoulder, back, and neck) was collected from the questionnaire. Standard agreement methods (percent agreement, Kappa), simple regression, and multilevel models were used to examine associations between the health outcomes with both group and individual level exposures.

### Results:

Agreement between the self-reported exposures and expert assessments was very poor ( $Kappa < 0.4$ ). However, both self-reports and expert ratings were positively associated with musculoskeletal outcomes.

Table I: Prevalence ratios for multilevel models containing individual and walkthrough exposure assignments with random effects

Health outcome	Exposure	PR (95% CI)		Intra-unit correlation	
		Self-report	Walkthrough		
Musculoskeletal symptoms	Shoulder pain	Shoulder exposure	1.17 (1.00 – 1.37)	1.42 (1.07 – 1.88)	0.013
	Neck pain	Neck exposure	1.52 (1.25 – 1.85)	1.39 (1.09 – 1.85)	<0.001
	Back pain	Back exposure	1.48 (1.26 – 1.74)	1.17 (0.88 – 1.55)	0.002
	Back pain	heavy lifting	1.31 (1.10 – 1.55)	1.20 (0.90 – 1.61)	0.005

PR = Prevalence Ratio; 95% CI = 95% Confidence Interval

**Bold values denote significant associations, where confidence intervals exclude the null**

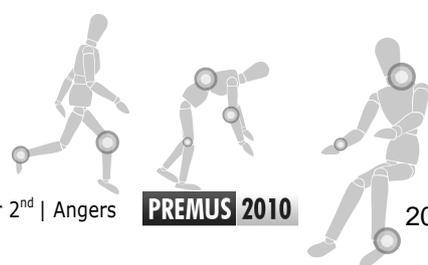
### Conclusion:

With the help of multilevel models, important positive associations between workplace exposures and musculoskeletal outcomes were observed, despite poor agreement between exposure assessment methods. Reasons for poor agreement between exposure assessment tools has been discussed in [Sembajwe G, et al. 2010] and include instrument precision, common variable bias, and the nature of the exposure. In the end, modeling exposure information from different levels (group and individual) showed that there was no group-level confounding or interaction between individual and job-level factors in the exposure-outcome associations.

**Keywords:** Postures, Physical exposure, Exposure measurement methods, Methods in epidemiology

### References:

Barbeau EM, Hartman C, Quinn MM, Stoddard AM, Krieger N. 2007. Methods for recruiting white, black, and hispanic working-class women and men to a study of physical and social hazards at work: The united for health study. *Int J Health Serv* 37(1): 127-144.  
 Quinn M, Sembajwe G, Stoddard A, Kriebel D, Krieger N, Sorensen G, Hartman C, Naishadham D, Barbeau E. 2007. Social disparities in the burden of occupational exposures: Results of a cross-sectional study. *Am J Ind Med* 50(12): 861-875.  
 Sembajwe G, Quinn M, Kriebel D, Stoddard A, Krieger N, Barbeau E. 2010. The influence of sociodemographic characteristics on agreement between self-reports and expert exposure assessments. *Am J Ind Med* [In Press].



## RELIABILITY OF JOB-TITLE PHYSICAL WORK EXPOSURES FOR THE UPPER EXTREMITY: COMPARISON TO SELF-REPORTED AND OBSERVED EXPOSURE ESTIMATES

TAYLOR-GARDNER B.T., LOMBARDI D.A., DALE A.M., FRANZBLAU A., EVANOFF B.

Washington University School of Medicine, St. Louis, MISSOURI, USA. Liberty Mutual Research Institute of Safety, Hopkinton, MASSACHUSETTS, USA. University of Michigan School of Public Health, Ann Arbor, MICHIGAN, USA.

### Aims:

To evaluate the agreement between different estimates of upper extremity physical work exposures, using three methods: job-titles with estimates from O\*NET, job observation, and worker self-report.

### Methods:

The study group consisted of 972 workers in several industries that provided self-reported physical work exposures from a questionnaire 6 months after starting a new job. Videotaped worksite observational exposure assessments were completed for a subset of approximately 400 workers(1).

Self-reported exposures were collected using a modified Nordstrom(2) questionnaire, for average daily time of eight physical exposures: hand/wrist bending, forearm rotation, pinch grip, use of vibrating power tools, finger/thumb pressing, forceful grip, lifting >1 kg, and assembly line tasks. Videotaped work observations were rated by expert consensus on exposures including the Nordstrom scales and ACGIH HAL-TLV.

Based on job title, selected exposure variables were extracted from O\*NET, a publicly available database developed by the U.S. Department of Labor(3), including handling/controlling objects, handling/moving objects, static and dynamic strength, manual dexterity, finger dexterity, making repetitive motions, and wrist-finger speed. We evaluated agreement between workers' self-reports and observer ratings of exposure with O\*NET variables using Spearman rank correlations and intra-class correlation coefficients (ICCs).

### Results:

The O\*NET variables showed stronger agreement with observed exposure estimates than self-reported estimates, for most exposures examined. The highest levels of agreement were seen with the O\*NET variables related to handling objects (ICC=0.81) and strength demands (ICC=0.66). Weaker agreement was seen for dexterity variables (ICC=0.52), and almost no agreement for repetition variables (ICC=0.14).

### Conclusion:

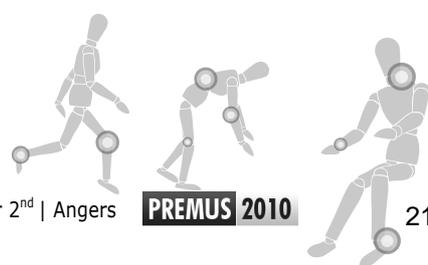
Stronger agreement was found when the comparison involved the same dimension of exposure in the rating scales (i.e. frequency, duration, intensity). One limitation of assigning exposure information to individual workers based upon job title is potential exposure misclassification, as exposures may differ among individuals with the same job title.

Although several studies have successfully used O\*NET data as a supplemental source for job information when exposure data are unavailable or limited, few have compared the estimates to other exposure estimate methods. Our study found that these job-title based exposure estimates showed good agreement with observed exposures for some variables, and poor agreement with others. Further validation of these data is necessary to determine the utility of the O\*NET databases in future epidemiological studies.

**Keywords:** Exposure measurement methods, Methods in epidemiology, Upper limb

### References:

1. Dale AM, Strickland J, Gardner B, Symanzik J, Evanoff BA. Assessing Agreement of Self-reported and Observed Physical Exposures of the Upper Extremity. *Int J Occup Environ Health*. 2010 Jan;16(1):1-10.
2. Nordstrom DL, Vierkant RA, Layde PM, et al. Comparison of self-reported and expert-observed physical activities at work in a general population. *Am J Ind Med*. 1998 Jul;34(1):29-35.
3. Consortium ON. What is O\*NET. US Department of Labor, Employment and Training Administration; 2007 [updated 2007; cited 2007 September 28]; Available from: [www.onetcenter.org](http://www.onetcenter.org).



## THE ACCURACY OF SELF-REPORT IN DETERMINING COMPUTER USE DURATION

BAKER N.A., MOEHLING K., XIU K.H.

*Department of Occupational Therapy, University of Pittsburgh, Pittsburgh, Pennsylvania, USA*

### Aims:

Studies on the effect of computer use on MSD use self-reported computer time to determine duration of exposure. This study examined the accuracy of self-report as a means to determine exposure to computer use.

### Methods:

Staff and faculty from a large university identified: hours of computer use and estimated percent time using the keyboard and mouse. Software measuring actual equipment use (Wellnomics WorkPace™) was installed and actual keyboard use (time striking keys) and actual mouse use (time moving/clicking mouse) were measured for one week.

The average actual keyboard and mouse times were summed to obtain overall actual computer time. The actual percent time was calculated by dividing each equipment time by the computer time. Self-reported estimates of keyboard and mouse time were calculated by multiplying the estimated percent time for keyboard and mouse use by the estimated hours of computer use.

Dependent t-tests were used to determine if there were significant differences between the estimated and actual times. Effect size *d* was calculated.

### Results:

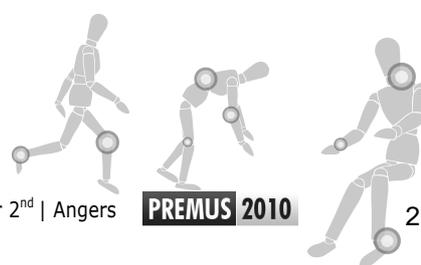
34 subjects, mean age 45.0±10.1 yrs, completed the measures. There were significant differences between all estimated time and actual time except for minutes of mouse use (Table 1).

	M	SD	<i>p</i>	<i>d</i>
Est. computer time (min)	369.71	±94.79	<.001	2.42
Act. computer time (min)	184.24	±58.22		
Est. keyboard time (min)	238.59	±85.21	<.001	3.64
Act. keyboard time (min)	46.62	±20.34		
Est. mouse time (min)	131.12	±67.14	.67	-0.12
Act. mouse time (min)	137.62	±44.79		
Est. % time keyboard	64.56	±17.12	<.001	3.27
Act. % time keyboard	25.18	±6.94		
Est. % time mouse	35.44	±17.12	<.001	-3.27
Act. % time mouse	74.82	±6.94		

### Conclusion:

Subjects were very inaccurate in their estimation of actual physical computer use time. Subjects perceived that they used their computer on average, 6 hrs/9 mins per day, and actually used it half as much (3 hours/4 mins). They reported an average of 3 hrs/59 mins of keyboard use, but used it on average, 2 hrs/11 mins. They perceived that they used their keyboard twice as much as their mouse, when, in reality, they used the mouse 3 times as much. Studies examining MSD and computer use should measure actual computer use to accurately determine exposure.

**Keywords:** Computer work, Exposure measurement methods, Methods in epidemiology



## OREGE, A RELEVANT ANALYSIS TOOL FOR EVALUATING BIOMECHANICAL STRESSES IN VARIOUS WORK SITUATIONS

CAIL F., AUBLET-CUVELIER A., RENO G.

*Institut National de Recherche et de Sécurité, Vandoeuvre les Nancy, France*

### Aims:

A 3-year study of upper limb musculoskeletal disorders (ULMSD) was conducted at 3 companies involving beef slaughtering and cutting (A), packing of printers (B) and working with display units in a banking environment (C). The purpose was to investigate ULMSD development with time based on variations in the main risk factors. Information on health and risk factors was repeatedly collected every 6 months over the 3-year period.

### Methods:

Within the scope of this study, biomechanical stress-related data were obtained by metrology and compared with data provided by direct observation using the OREGÉ tool developed by INRS [1]. With regard to the metrology, exertion forces were evaluated by surface electromyography (EMG) of wrist and finger flexors in the dominant hand. Movement repetitiveness (number of wrist flexion-extension movements per minute) was evaluated using an electrogoniometer placed on the dorsal faces of the dominant hand and forearm. Use of OREGÉ enabled upper limb exertion forces and movement repetitiveness to be estimated by comparing specialist and operator assessments. The data are for 3 workstations at company A, 6 at company B and 3 at company C.

### Results:

Exertion force results show close agreement between OREGÉ and EMG-based methods. In addition, this biomechanical constraint is uniform within each company. On the other hand, there is less agreement in movement repetitiveness between OREGÉ and the biomechanics because OREGÉ evaluates movement of the whole upper limb, whereas the electrogoniometer measures only wrist movement. Nevertheless, ranking of biomechanical stresses at the workstations is similar for OREGÉ and biomechanical metrology, if exertion forces and movement repetitiveness are combined in both approaches.

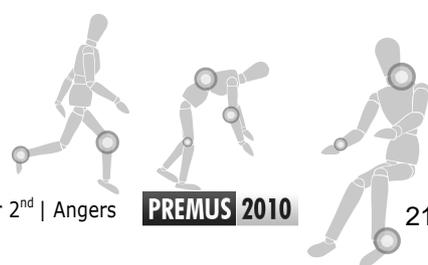
### Conclusion:

The OREGÉ tool thus proves its relevance within the framework of a global approach combining exertion force and movement repetitiveness for differentiating workstation classes in biomechanical stress terms.

**Keywords:** Biomechanics, Exposure measurement methods, Upper limb

### Reference:

Aptel M., Lafaurie S., Tronchet L., Atain-Kouadio J.J. OREGÉ : un outil simple d'évaluation des facteurs de risque biomécaniques de TMS du membre supérieur. Vandoeuvre : Institut National de Recherche et de Sécurité, 2000, Note scientifique et technique, 196, 122 p.



## VALIDATION OF A GENERAL INJURY PREDICTION ALGORITHM

CAMPBELL-KYUREGHYAN N., AHMED M., COOPER K.

*University of Wisconsin-Milwaukee, Center for Ergonomics, Milwaukee, USA*

### Aims:

Studies have shown the importance of analyzing accident causations (Dien, 2004) and the nature of injuries in order to prepare and implement preventative strategies in the workplace (Bull, 2001). Occupational and Safety Health Administration (OSHA) recordables are universally used in the US to quantify workplace safety but do not allow for direct determination of injury risk factors (Ahmed, 2009). The aim of this study was to develop and validate a data sorting algorithm that links OSHA recordables to the jobs most at risk and highlights the risk factors most in need of intervention efforts.

### Methods:

The algorithm uses OSHA recordables to determine the factors most responsible for each incident. The factors are ranked by prevalence and then linked to the specific jobs exposed to each factor. The algorithm output is a ranked list of jobs that are most likely to result in injuries, allowing the company to prioritize interventions. The algorithm was developed using five years (2004-2008) of data from a 3500-employee power utility. The algorithm predictions are compared to the results for the latest data (2009) to validate the predictive power of the approach.

### Results:

Injuries from the five years of data were sorted into six categories which were analyzed using the algorithm to identify the five most common injury causes. The jobs most exposed to each risk factors were then determined. These results served as a prediction for future injuries for both the jobs most likely to sustain injuries and the contributing risk factors. Validating the predictions with 2009 data revealed the same jobs experiencing the most injuries and a similar ranking of risk factors. For example, based on the algorithm predictions, interventions were implemented to mitigate the awkward posture/overexertion risk factors. The results indicate that these efforts were successful, with awkward postures/overexertion involved in only 3% of the injuries as opposed to 17% in previous years.

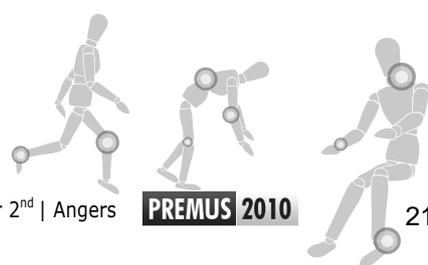
### Conclusion:

The advantage of the algorithm lies in its simplicity and wide applicability. Utilizing a systematic retrospective analysis of OSHA recordables, the algorithm provides accurate predictions of the jobs most likely to suffer future injury occurrences and the responsible risk factors. Validation of the method using 2009 injury data demonstrates the power of the method and illustrates the sources of variability. Predicting the highest risk jobs and associated risk factors allows for rational prioritization of intervention implementation and targeting of those interventions to the actual cause of injuries.

**Keywords:** Specific sectors, exposure measurement methods, intervention methods

### References:

- Ahmed M, Cooper K, Campbell-Kyureghyan N. Development of an algorithm to evaluate injuries among power utility workers. ISOES. Dallas: 2009.
- Bull N, Riise T, Moen B. Mechanisms of occupational injuries reported to insurance companies in Norway from 1991 to 1996. Am J Industrial Med. 2001;39:312-319.
- Dien Y, Llori M, Montmayeul R. Organizational accidents investigation methodology and lessons learned. J Hazardous Materials. 2004;111:147-153.



## AN APPROACH TO COMBINING PREDETERMINED TIME ANALYSIS WITH ERGONOMIC EVALUATION AT ASSEMBLY LINE DESIGN STAGE

CLAUDON L., MARSOT J.

INRS - Work Equipment Engineering Division, Rue du Morvan, F-54519 VANDOEUVRE LES NANCY Cedex

### Aims:

Designers seek gesture optimization without considering musculoskeletal disorder (MSD) risk factors, when specifying manual operations for an assembly line workstation. The aim of this study was to present a software-based approach to combining predetermined time analysis (Karger and Bayha, 1975) with main MSD biomechanical risk factor evaluation, whilst minimizing entry of upper limb posture data.

### Methods:

Software was developed to combine MTM-2 predetermined time analysis with evaluation of:

- shoulder movement frequencies,
- OCRA indexes for right and left hands (Occhipinti, 1998).
- A database containing upper limb joint angles for 792 reach postures was set up using a digital manikin (DELMIA/HUMAN) to facilitate the designer's task. The digital manikin upper limb was successively positioned at 60 equidistant points (200 mm) forming a grid within the volume of a seated workstation. This database was used for deriving approximate upper limb postures from hand locations and orientations associated with each manual operation.
- An initial validation stage involved 9 workstations at an automobile industry subcontractor. The real manual operations were translated into MTM-2 language from videos. Comparisons were made between software- and visual observation-based results.

### Results:

The results revealed similar shoulder movement frequencies based on software computations and visual observations. Only 3 shoulder extensions ( $\Theta_{flex-ext} < 0^\circ$ ) were not detected by the software. These situations could be explained by the low shoulder extension angles ( $-20^\circ < \Theta_{flex-ext} < 0^\circ$ ) and the inaccuracy caused by the the grid spacing. A correlation coefficient of 0.94 between OCRA indices computed using the software and those resulting from observation was calculated. The small differences between these two sets of OCRA index values can be explained by the slightly different cycle times between observation and translation of the real activity into MTM-2 language.

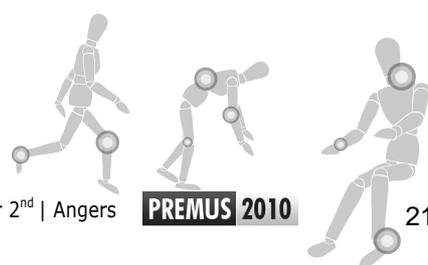
### Conclusion:

This study demonstrates the feasibility of combining a predetermined time analysis, describing the operating procedure of both hands, with ergonomic evaluations at design stage. Such a process would assist in designing less stressful future working conditions. However, this type of approach calls into question the representativeness of the simulated (specified) activity compared with the future (real) activity; this would confirm the need to evaluate also the future activity.

**Keywords:** Postures, Physical exposure, Early prevention

### References:

Karger D. W., Bayha F. H. La mesure rationnelle du travail MTM et systèmes de temps prédéterminés. Gauthier-Villars (Ed), Paris, ISBN 2-04-004469-2, 1975, 424 p.  
Occhipinti E. (1998). OCRA : A concise index for the assessment of exposure to repetitive movements of the upper limb. Ergonomics. 1998; 41 : 1290-1311.



## WORK RELATED SHOULDER LOADS: ESTABLISHMENT OF A JOB EXPOSURE MATRIX

ANDERSEN A.D.<sup>1</sup>, SVENDSEN S.W.<sup>2</sup>, FROST P.<sup>1</sup>, HANSSON G.Å.<sup>2</sup>, ANDERSEN J.H.<sup>3</sup>

<sup>1</sup> Danish Ramazzini Center, Department of Occupational Medicine, Aarhus University Hospital, Aarhus, Denmark - <sup>2</sup> Department of Occupational and Environmental Medicine, Lund University Hospital, Lund, Sweden - <sup>3</sup> Danish Ramazzini Center, Department of Occupational Medicine, Regional Hospital West Jutland, Herning, Denmark

### Aims:

The aim of this ongoing study is to construct a Job Exposure Matrix (JEM) for mechanical shoulder loads in Denmark based on expert judgements and technical measurements.

### Methods:

The two dimensions of the JEM will be occupations and mechanical shoulder exposure variables. The occupational dimension will be divided according to the Danish Version of The International Standard Classification of Occupations (DISCO-88) that includes 2227 Danish job titles. The 2227 job titles will be subdivided into approximately 120 occupational categories with expected homogeneous exposure patterns. The exposure variables will comprise mechanical shoulder loads such as working with elevated arms, repetitive arm movements, forceful exertions and vibration. If possible all three exposure dimensions (level, frequency and duration) will be included.

The exposure assessment will be based on expert judgements and technical measurements. The expert judgements will be performed by 5 specialists in occupational medicine. The technical measurements will include whole day inclinometer recordings performed at the workplace. In the measurement programme, priority will be given to frequent job titles in Denmark and less frequent job titles with expected high levels of exposure, which will weight heavily in exposure-response analyses. To obtain occupational group mean values, ten measurement days will be distributed on different individuals from each of the selected job titles. We anticipate obtaining a total of 400 measurement days. Representative individuals from selected job titles will be identified among participants in a public health investigation in Central Denmark Region. Previous inclinometer measures from Sweden as well as previous measures obtained with another type of equipment, the abduflex, may be incorporated into the JEM.

### Results:

The exposures will be assessed on continuous scales, and mean levels of exposure will be estimated. If possible expert judgements and technical measurements will be combined and a measurement-estimate will be calculated for occupations not measured.

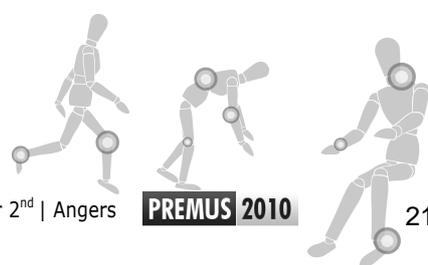
### Conclusion:

The JEM can be applied as a general shoulder exposure information system for hazard control and risk quantification. In further studies the JEM will be employed for exposure assessment in a Danish population-based register study of surgery treated shoulder disorders, where exposure-response relationships will be established. The JEM will also be employed in a case-referent study to investigate the risk of surgery treated shoulder disorders in relation to mechanical shoulder exposures, taking into account probable confounders.

**Keywords:** Exposure measurement methods, methods in epidemiology, upper limb

### References:

- Kauppinen T, Toikkanen J, Pukkala E. From cross-tabulations to multipurpose exposure information systems: a new job-exposure matrix. *Am J Ind Med.* 1998 Apr; 33(4):409-17.
- Svensden S.W, Mathiassen S.E, Bonde J.P. Task based exposure assessment in ergonomic epidemiology: a study of upper arm elevation in the jobs of machinists, car mechanics, and house painters. *Occup Environ Med.* 2005 January; 62(1): 18-27.
- Hansson G-Å, Balogh I, Ohlsson K, Granqvist L, Nordander C, Arvidsson I, Åkesson I, Unge J, Rittner R, Strömberg U, Skerfving S. Physical workload in various types of work: Part II. Neck, shoulder and upper arm. *International Journal of Industrial Ergonomics*, in press 2009.



**TO INCREASE THE AWARENESS OF PRIMARY CARE PHYSICIANS REGARDING THE OCCUPATIONAL PART OF SOME DISEASES. THE EXAMPLE OF MSD TO IMPROVE THEIR PROFESSIONAL PRACTICES.**

LANOT S.<sup>1</sup>, DELEPINE A.<sup>2</sup>, ZANA J.P.<sup>2</sup>

<sup>1</sup> Pacte-Asset, Alençon, France - <sup>2</sup> INRS, Paris, France

**Aims:**

To prevent occupational diseases, especially MSD, by way of better information of primary care physicians.

**Methods:**

Through the initiative of the INRS, a regional-based Association of Continuing Medical Education, called “Pacte-Asset,” brought together general practitioners and a rheumatologist, following the “peer group” methodology, on the basis of nine monthly meetings. An INRS physician and a journalist systematically ran these meetings. Occupational physicians, the regional Social Security consultant physician, the regional labour inspectorate physician and an ergonomist were heard from, as experts. During the meetings, case studies, brought forward by the participants, were analyzed to highlight the connections between MSD and work, with the help of the INRS physician and experts.

**Results:**

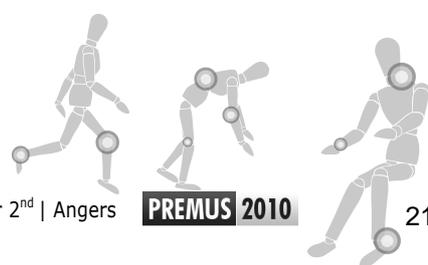
The awareness of the peer group increased concerning the relations between work and MSD. Moreover, the group elaborated recommendations to be transferred to primary care physicians, in order to make them sensitive to the possible occupational origin of some illnesses and to help them taking into account occupational factors during their medical consultations.

**Conclusion:**

Most of the general practitioners involved in the peer group discovered the field of professional pathology.

In the future, it will be necessary to assess the impact of such an experiment, particularly concerning the evolution of their practice, in relation with the occupational diseases socio-medical assumption of responsibility.

**Keywords:** Pain chronic pain, Disability prevention, Social aspects of MSD



## ASSOCIATING BIOMECHANICS AND AUTO-CONFRONTATION FOR A BETTER UNDERSTANDING OF THE MOVEMENT MADE

AUBLET-CUVELIER A., GAUDEZ C., LEVESQUE S., WIOLAND L.

*Institut National de Recherche et de Sécurité, Département Homme au Travail, Vandoeuvre-les-Nancy, France*

### Aims:

Musculoskeletal disorders are multifactor pathologies with movement as their common component. Understanding movement pre-assumes an analysis model embracing various dimensions: psychological, organisational, economic, biomechanical and cognitive (Bourgeois & Hubault, 2005). The purpose of this study was to link the physiological dimension of a movement with its intentions and motives. To achieve this, we tested a work activity analysis methodology based on the association of biomechanical metrology and auto-confrontation.

### Methods:

The study was conducted at a book binding company, more specifically at the plastic-covering workstation, at which a complex manual activity is performed. Biomechanical metrology and auto-confrontation were sequentially deployed. During the initial stage, an overall analysis of the company and its functioning was performed, along with a specific plastic-covering activity analysis. Within this framework, a first self-confrontation session was undertaken on the four female operators, who usually perform this plastic-covering activity. The summary derived from this first stage led to definition of the biomechanical metrology experimental procedure. The operator activity was filmed at the same time as biomechanical data was acquired. The summary of results provided by initial auto-confrontation combined with biomechanical metrology led to definition of the procedure for the second self-confrontation, which was subsequently implemented. Biomechanical data and verbalisations from both auto-confrontations were first analysed separately before being combined.

### Results:

Agreement of results from biomechanical metrology and both self-confrontations is fairly infrequent. This observation may be explained by the characteristics that are specific to each method. Auto-confrontation in fact provides global-type data, taking into account the entire task and the individual, whilst biomechanics provides data targeting more the task and the individual.

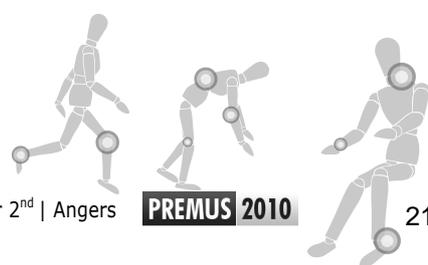
### Conclusion:

Although these methods deal with different aspects of the activity and the individual, the advantage of their association resides in mutual enrichment based on detailed knowledge of the movements made by the operator. It was therefore possible to reveal and/or detail certain, more or less fine, determining factors ranging from the activity's organisational context to finger movement. This knowledge can be helpful to the prevention specialist when identifying action-based levers for controlling MSD risk.

**Keywords:** Biomechanics, Psychosocial factors, Intervention methods

### Reference:

BOURGEOIS F., HUBAULT F. - Prévenir les TMS : de la biomécanique à la revalorisation du travail, l'analyse du geste dans toutes ses dimensions. @ctivites revue électronique, 2, 1.



## EVALUATION OF ERGONOMIC POSTURES OF ASSEMBLING UNIT WORKERS BY RAPID UPPER LIMB ASSESSMENT (RULA)

GHASEMKHANI M., AZAM K., ATEN S.

School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

### Aims:

Musculoskeletal disorders are major causes of work-related disability for many occupational groups(1). Rapid Upper Limb Assessment (RULA) is a method developed for use in ergonomic investigations of workplaces where work-related upper limb disorders are reported. RULA is a screening tool that assesses biomechanical and postural loading on the whole body with particular attention to the neck, trunk and upper limbs (2). This study was performed to assess ergonomic postures of car industry assembling unit workers in Tehran, using RULA .

### Methods:

A sample consisting of 196 workers with 37 postures were selected from assembling units (trim, mechanical and seat installation lines). Ergonomic postures were assessed using RULA. Nordic Musculoskeletal Disorders Questionnaire (NMQ) was used as data collection tools. The analysis was executed using SPSS (ver.11.5) statistical package. The level of significance was set at  $P < 0.05$ .

### Results:

The highest percent of inappropriate postures were in score seven and action level four, in all three lines. No differences were found between the three lines in scores and actions levels.



### Conclusion:

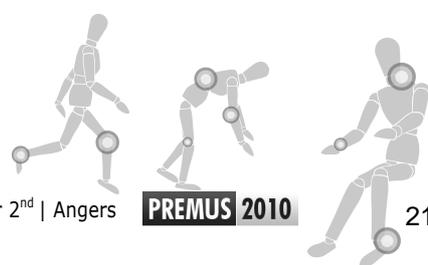
The results indicated that inappropriate postures may be major causes of work-related disability. It is concluded that working conditions and postures need to be improved and changes are required immediately.

**Keywords:** Postures, Physical exposure, Personal risk factors for MSD, Upper limb

### References:

National Institute for Occupational Safety and Health (NIOSH): Musculoskeletal disorders and workplace factors: A critical review of epidemiologic evidence for work-related disorders of the neck, upper extremity, and low back. USA: DHHS (NIOSH) Publication;1997: 97-141.

McAtamney L, Corlett EN. RULA: A survey method for the investigation of work-related upper limb disorders. Appl Ergon 1993; 24: 91-99.



## INTEGRATED ASSESSMENT OF PHYSICAL STRESS (IAD-BKB)

GHEZEL-AHMADI K., SCHAUB K., BRUDER R.

*Development of a method for integrated assessing muscular stress in the scope of reward requirements of the small and medium-sized metal and electrical companies.*

### Aims:

Physical stress at assembly work could be characterized by poor postures, also by practicing of applied forces, manual handling of loads and short cyclic / repetitive stress of the finger-hand-arm-system.

There are methods in literature that allow an ergonomic assessment of single stress concentration; but there are no methods concerning applicable integrated assessment. This gap is closed by the method of IAD-BKB.

### Methods:

The analysis states that force performance and handling of loads is primarily significant at assembly work. The handling of loads includes lifting and carrying as well as pushing and pulling. The description of further parameters, like direction of force and position of articulation, is not to neglect because of its relevance. Stress of hand-arms systems emerges now at all-embracing surveys of assembly work lines must be adequately recorded for an integrated assessment.

One aim of developing IAD-BkB was the consideration of a whole body and hand-arm-finger posture that (close to the handling of loads module) consists of parameters such as force and time, and includes as well the position of articulation, the direction, and the character of the exercised force and process parameters. A further aim of this Development is the combined posture risk assessment.

### Results:

IAD-BkB is developed as a screening method for assessing physical stress on the basis of a method for risk analysis and assessment at physical work.

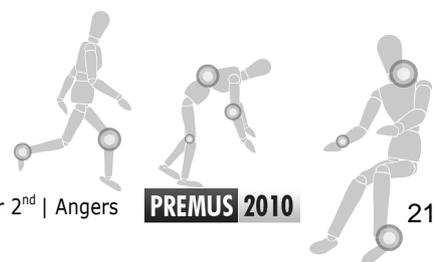
Since more than Three years the "IAD-BkB" is used at a huge Number of companies in Germany to analyze current and planned assembly and logistic workplace processes.

Now it is time for an appraisal and demonstration.

### Conclusion:

Close to this measurements are secondary prevention measurements that identify early work-related health disturbances and counteract with necessary means. But this requires continuous supervision by occupational physicians, which is still not possible in small and medium sized businesses. Bigger enterprises can use their own occupational medicine department as a tool that supports the cooperation between production planning and fair employability.

**Keywords:** Postures, physical exposure, Exposure measurement methods



## ERGONOMICS HAZARDS EVALUATION OF THE VISUAL INSPECTION PROCESS IN THE LIGHT EMITTING DIODE INDUSTRY

CHI-LING H., CHIH-WEI L.

Graduate Institute of Occupational Safety and Health, Kaohsiung Medical University, Kaohsiung City, Taiwan

### Aims:

The aim of the study was to analyze the visual inspection Process for operators in the LED industry. In this study, we use a questionnaire and a checklist to evaluate the ergonomic hazards in this industry

### Methods:

In the experiment, musculoskeletal disorders (MSD) questionnaire, ergonomics checklists (RULA) were used to measure the musculoskeletal disorder syndromes of operators. We divided the Visual Inspection work into several workstations: Overturn, Spot check, Visual Examine, Strain, Count, Deposit, and Arrange. We recorded these work with a video record and evaluate with RULA checklist. There were 64 Visual Inspection Task operators participated in this study. To go step further, we divided the subjects by their work contents: Spot Test, Visual Check, and Arrange.

### Results:

The result shows that the uncomfortable frequency of body parts were 73.7% in neck, 60.6% in shoulder, 34.9% in upper back, 45.31% in wrist and 29.69% in lower back, respectively. And the statistical analysis indicates MSD was significant correlated ( $p$

### Conclusion:

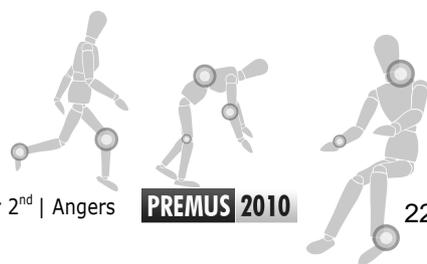
By the NMQ questionnaire result, the musculoskeletal disorder syndromes are major in upper limb and neck and shoulder are the most common body part in the Visual. To go step further, the factor which influences the total workers' uncomfortable syndromes is BMI. Seniority could influence the workers' uncomfortable syndromes in Spot Test.

The RULA checklist indicates that Overturn, Strain, and Count are the workstations which have critical potential hazards. The standard operating procedure (SOP) improvement and the workstation redesign were being suggested to reduce the danger of musculoskeletal disorder syndromes.

**Keywords:** Postures, Physical exposure, Epidemiology

### References:

- Alfons Kreczy, M.K., Andreas Gschwendtner, Underestimated health hazard: proposal for an ergonomic microscope work station. THE LANCET, 1999. 354: p. 1701.  
Chen C., Du C., Kuo Y., The survey of electron workers' skin disease and musculoskeletal disorder syndromes. 1996  
Hung Y., The static and activity loading analysis about neck and shoulder in Visual Inspection Task, master thesis in Industry Engineering Graduate School. 2004. National Taiwan Science and Technology University



## DEVELOPMENT OF A WORKSTYLE OBSERVATION PROTOCOL - A PART OF AN INSTRUMENT FOR ASSESSMENT OF CASH-REGISTER WORK (BASIK)

JOHANSSON E., PALM P., KJELLBERG K., JOSEPHSON M.

Uppsala Universitet, Sweden

### Aims:

Work technique is one aspect of the workstyle concept (1). An instrument for work technique was developed, as a part of a broader instrument for assessing workstyle in cash-register work (BASIK). The aim was to identify relevant aspects of work technique and to evaluate the test-retest reliability of the observation protocol.

### Methods:

Video recordings of cashiers performing cash-register work were studied to identify differences in how they performed their work tasks. Observational items were constructed according to identified differences in work technique between the cashiers. Only work technique aspects that have importance for the development of upper extremity disorders according to current ergonomic knowledge, and aspects that could not be explained by workstation design, were included in the protocol. A workshop with ergonomists was performed to ensure the relevance of the identified items. To evaluate the test-retest reliability of the protocol one ergonomist made two assessments of 17 video recordings with at least 19 days apart (median 22 days, max 39 days). Each film was approximately 15 minutes long, showing cashiers performing cash-register work. Concordance between the two assessments was calculated (% agreement and Kappa).

### Results:

The final protocol consisted of 10 items identified as relevant when assessing working technique in cash-register work. 6 items showed good or very good intra-observer agreement (table 1).

Table 1. Test-retest reliability of the items in the protocol, % agreement, Cohen kappa (K) and strength of agreement according to guidelines (2).

Item	%	K	Strength of agreement
Working posture	100	1.00	Very good
Works with tense shoulders	82	0,34	Fair
Makes use of micropauses when possible	82	0,64	Good
Works with rapid or gentle movements	88	0,78	Good
Waits for the conveyor to move goods as close as possible	76	0,44	Moderate
Lifts the groceries	94	0,88	Very good
Works with small wrist movements	76	0,39	Fair
Drops the groceries direct at the conveyor after scanning	94	0,88	Very good
Works continuously with twisted neck	82	0,64	Good
Keeps the arm elevated when waiting for the receipt	76	0,51	Moderate

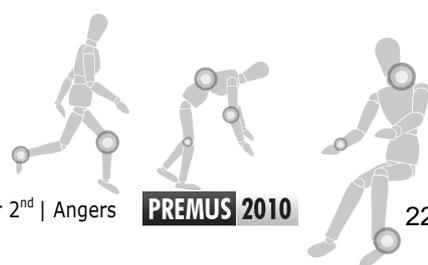
### Conclusion:

The test-retest results showed an acceptable intra-observer reliability for most of the items. Few persons in the material were assessed as working with tensed shoulders. This might explain the modest Kappa-value but relatively high percent agreement for that item. This observation protocol is hopefully valuable for occupational health services and other occupational health actors to identify aspects of work technique in cash-register work that may be improved.

**Keywords:** Postures, physical exposure, intervention methods, upper limb

### References:

1. Feuerstein M, Shaw WS, Nicholas RA, Huang GD. From confounders to suspected risk factors: psychosocial factors and work-related upper extremity disorders. *Journal of Electromyography and Kinesiology*. 2004;14(1):171-178.
2. Altman D. Some common problems in medical research. In: *Practical statistics for medical research*. London: Chapman & Hall; 1991. p. 396-439.



## DEVELOPMENT OF A WORKSTYLE QUESTIONNAIRE - A PART OF AN INSTRUMENT FOR ASSESSMENT OF CASH-REGISTER WORK (BASIK)

KJELLBERG K., PALM P., JOHANSSON E., JOSEPHSON M.

*Department of Public Health Sciences, Karolinska Institutet, Stockholm, Sweden*

### Aims:

To develop a questionnaire for the occupational health services and other occupational health actors, as a part of a broader instrument for assessment of workstyle in cash-register work (BASIK). The instrument is intended to be used as a tool to identify high-risk workstyle and needs for interventions, e.g. training and education. Furthermore, to study workstyle among cashiers in supermarkets during high work demands.

### Methods:

The questionnaire was mainly based on the workstyle model proposed by Feuerstein et al [1] which describes how ergonomic and psychosocial factors interact in the development of work-related upper extremity disorders. A measure of workstyle has also been developed and used mainly on office work [1]. In the present study the workstyle model was modified to cash-register work. Some of the items in the measure were selected, translated to Swedish, and modified to cash-register work. All questions apply to cash-register work situations with a continuous flow of groceries and customers. The items were discussed with cashiers and researchers who have performed studies of cashiers. The items were modified and ratings of subjective experiences of stress and pain intensity were added [2, 3]. The comprehensibility and relevance of the items were discussed in focus group interviews with cashiers, which led to further revisions. 44 cashiers at five supermarkets answered the questionnaire and, as a test-retest, 24 of them completed the questionnaire again after three weeks.

### Results:

The questionnaire consists of workstyle items about self-imposed workpace, social reactivity, e.g. fears of making mistakes, muscle tension, and working through pain. The ratings of stress cover negative experiences (stressed, exhausted, tense and irritable) and positive experiences (concentrated, energetic and happy). Pain intensity is rated in nine body regions. Examples of results are that 39% of the cashiers reported that they often tried to work harder than their colleagues in work situations with a continuous flow of customers. 40% reported neck pain, 61% shoulder pain and 23% pain in the wrists/hands in these situations. Almost all of those who had musculoskeletal pain continued to work in the check-out in spite of pain. Few asked to be replaced with a colleague when having pain. The cashiers rated the positive experiences higher than the negative. The test-retest reliability was satisfactory for most of the items.

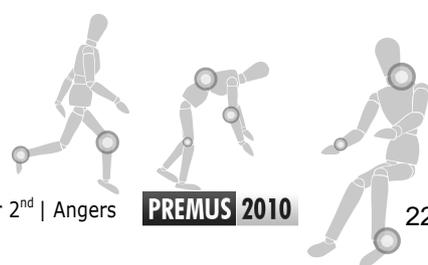
### Conclusion:

The questionnaire seemed useful and relevant for assessment of workstyle in cash-register work.

**Keywords:** Psychosocial factors, early prevention, upper limb

### References:

- Feuerstein M, Shaw WS, Nicholas RA, Huang GD. From confounders to suspected risk factors: psychosocial factors and work-related upper extremity disorders. *J Electromyogr Kinesiol.* 2004;14(1):171-8.  
Rissen D, Melin B, Sandsjo L, Dohns I, Lundberg U. Surface EMG and psychophysiological stress reactions in women during repetitive work. *Eur J Appl Physiol.* 2000;83(2-3):215-22.  
Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain.* 1992;50:133 -49.



## VALIDATION OF THE GERMAN KEY INDICATOR METHOD “MANUAL OPERATIONS” REGARDING IDENTIFICATION OF MUSCULOSKELETAL HEALTH RISKS

LIEBERS F., STEINBERG U.

Federal Institute for Occupational Safety and Health (BAuA), Berlin, Germany

### Aims:

Repetitive arm movements are frequent work related demands. Nearly 65% of the employees in Germany are exposed [1]. It is well known, that exposures which are jointed to manual operations like repetitive movements, force requirements, extreme joint positions and hand-arm-vibrations can cause work-related complaints and disorders of the upper extremities and in the neck [2]. Therefore, we developed and tested a tool for risk assessment, the Key Indicator Method “Manual Operations” (KIM-MO) [3]. The aim of the tool is to support risk assessment on screening level for practitioners and experts. A substantial part of tool testing was the validation of the method. The target function of KIM-MO is, to estimate the probability of overload to the musculoskeletal system especially of the upper extremities. The aim of the study was to validate the tool regarding the power to identify musculoskeletal health risks in the case of manual operations at workplaces.

### Methods:

The study was designed as a cross sectional survey. We examined 23 workers operating printing machines and 43 operators in the semiconductor industry. An external historical cohort of 1055 workers at visual display units were used as controls. Workplace characteristics and demands were assessed by ergonomic experts (job demands, postures, movements, forces, rest regime, environmental aspects). Health complaints considered as outcomes were investigated by questionnaire and medical examinations. The association of these outcomes with workplace exposure and confounders was estimated using logistic regression models.

### Results:

Operating printing machines and machines in the semiconductor industry were characterized by frequent and forceful hand actions, unfavorable arm and body postures. Using the KIM-MO the risk for work-related health complaints at these workplaces were estimated at a level indicating an increased load situation. Physical overload at these workplaces was associated with complaints in the elbow, hand and foot region (odds ratios 2-3) among women as well as men.

### Conclusion:

The study validated in a first step the risk estimation of the new developed key indicator method “manual operations”. If tasks require high demands regarding manual operations, KIM-MO indicates an increased risk level. Physical overload is possible among healthy workers. The assessed exposures were associated with musculoskeletal health complaints, especially the upper extremities. Ergonomic redesign of the affected workplaces is recommended and could be evaluated by reassessment with KIM MO in a second step.

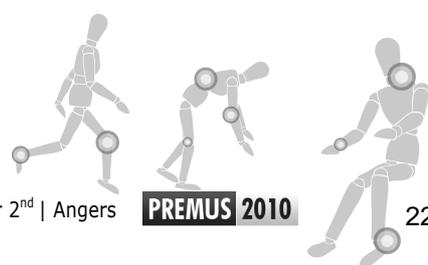
**Keywords:** Exposure measurement methods, Economics, Upper limb

### References:

Fourth European Working Conditions Survey / European Foundation for the Improvement of Living and Working Conditions. 2007. - Luxembourg: Office for Official Publications of the European Communities; Dublin: European Foundation for the Improvement of Living and Working Conditions.

Buckle P, Devereux J. 1999. Work-related neck and upper limb musculoskeletal disorders. Luxembourg: Office for Official Publications of the European Communities, European Agency for Safety and Health at Work.

Steinberg U, Behrendt S, Caffier G, Schultz K, Jakob M. 2007. Leitmerkmalmethode Manuelle Arbeitsprozesse. Erarbeitung und Anwendungserprobung einer Handlungshilfe zur Beurteilung der Arbeitsbedingungen. 1. Auflage. Dortmund: Bundesanstalt für Arbeitsschutz und Arbeitsmedizin.



## MSD RISK FACTORS IN RODWORKING: A TASK BASED ANALYSIS

MOORE A.E., SHANAHAN C., VI P., SALAS E.A., GARRITANO E.

School of Kinesiology and Health Science, York University, Toronto, Canada; Infrastructure Health and Safety Association, Toronto, Canada

### Aims:

Rodwork is the construction trade involved in the placing and tying of steel rebar for concrete reinforcing and has been found to expose workers to a variety of Work Related Musculoskeletal Disorder risk factors including extreme postures (particularly full trunk flexion and overhead reaching), carrying large loads and repetitive hand tool use, often over extended periods (Dababneh and Waters 2000; Buchholz et al 2003). As part of a larger study to examine task based ergonomic assessment in non-fixed work performed in different environments, it was necessary to confirm that Ratings of Perceived Exertion would distinguish tasks in rodwork as has been found elsewhere (Jang et al 2007). The goal of this paper was to compare the ability of ratings of perceived exertion to distinguish between rodwork tasks.

### Methods:

In consultation with trade representatives, a comprehensive list of 25 distinct tasks was created. Postural data of the trunk and upper limb and video data were collected from fourteen healthy, experienced male rodworkers from five different commercial sites for an average of 6 hours each. For each task performed, weights of tools/parts touched, environmental conditions, perceptual ratings of discomfort of the low back and wrist and exertion of lifting and grasping using Borg 10 scales were recorded.

### Results:

An average of  $28.7 \pm 5.9$  (mean  $\pm$  stdev) tasks were observed per worker over the course of a day of which  $8.3 \pm 2.1$  were distinct tasks. Across all workers, 20 distinct tasks were observed, of which the highest exertion and discomfort came from moving prefabricated structures. In one case 6 workers moved a 274 Kg structures (46 Kg/person). Of the seven most common tasks, two person lifts had the highest rated lift exertions. Tying (attaching two rods with wire) on a slab (floor) had the highest rated wrist and back discomfort. The average trunk angle was over 90 degrees for this task. The grasp exertion when tying on the slab was twice that of tying on a wall despite the use of the same wire and tool.

### Conclusion:

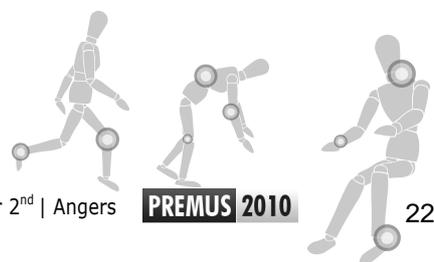
In conclusion, ratings of perceived discomfort and exertion did distinguish between tasks. The importance of capturing the infrequent but high exertion tasks is discussed. Of note, the increased grasp exertion is explored as a function of either the posture effects on perceived/actual hand forces or other task variables.

**Keywords:** Postures, physical exposure, construction, exposure measurement methods

### References:

Buchholz, B et al (2003) AIHA Journal. 64(2) 243 – 250

Dababneh AJ. And Waters TR. (2000) Applied Occupational & Environmental Hygiene. 15(10). 721-727., Jang R et al (2007) Ergonomics 50(11). 1835 – 1855



## THE FEASIBILITY OF USING VIDEO TRACKING FOR STUDYING ARM MOVEMENTS IN CASH-REGISTER WORK, A PILOT FIELD STUDY

PALM P., HELGESSON M., LAMPA E., KJELLBERG K., JOHANSSON E., JOSEPHSON M.

*Occupational and Environmental Medicine, Uppsala University and Uppsala University Hospital, Uppsala and Centre for Musculoskeletal Research, University of Gävle, Sweden.*

### Aims:

Work technique is one aspect of the Workstyle concept (1). An instrument for monitoring Workstyle in cash-register work (BASIK), including an observational protocol for work technique, was developed for the occupational health services. To ensure the validity of items in the protocol that focused on reach patterns there was a need for objective methods. The aim of this study was to determine the feasibility of using video tracking technique in field to identify reach patterns in cash-register work.

### Methods:

Videos (8-16 min) were recorded with a standard DV-camera from four different cashiers in two different supermarkets. Markers on the wrists were tracked afterwards with a video tracking software (TEMA 3.3). Periods of scanning work were identified within the whole cash-register work, so that e.g. payment and waiting time was deleted. The time proportions of the hand positions (XY) were illustrated with plots of bivariate kernel density estimates (R2.90). To relate the hand positions to the check-out systems and the cashiers, the plots were scaled and superimposed over still pictures from the videos.

### Results:

Differences in reach pattern could be identified with the videotracking technique (figure 1). Cashier C and D reached more with their hands than A and B. Cashier B used her right hand less than cashier A. One minute took about 18 minutes to track (left and right hand).

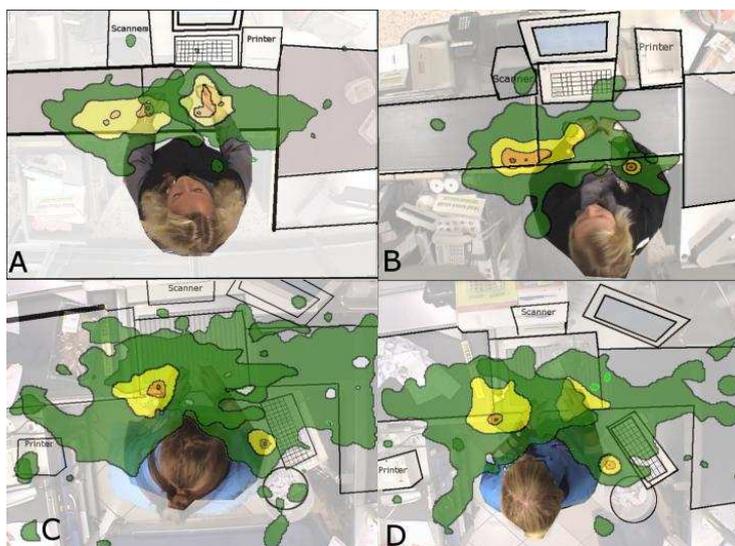


Figure 1. Hand positions in four different cashiers and two different checkout systems. 99th, 75th, 25th and the 1th percentile of time proportion.

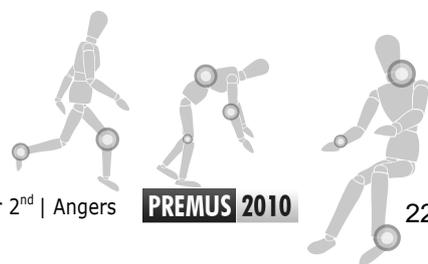
### Conclusion:

Recording cashiers work in the field with a standard dv-camera is feasible, but the tracking process is time consuming, mainly due to frequent loss of the tracker positions. Video tracking technique in field studies might be feasible for analyzing short work cycles in stationary work situations. The tracking technique thus seems useful for validating items in the work technique protocol in BASIK focussing on reach patterns.

**Keywords:** Postures, Physical exposure, Exposure measurement methods, Upper limb

### Reference:

Feuerstein M, Shaw WS, Nicholas RA, Huang GD. From confounders to suspected risk factors: psychosocial factors and work-related upper extremity disorders. *Journal of Electromyography and Kinesiology*. 2004;14(1):171-178.



## EXPOSURE ASSESSMENT OF MUSCULOSKELETAL DISORDER RISK FACTORS IN NON-ROUTINIZED WORK: A NEWLY REVISED PATH TOOL

PARK J.K., HAN Y.S.

*Korea Occupational Safety and Health Agency, Korea*

### Aims:

A version of PATH (Posture, Activity, Tools and Handling) method was newly revised and applied to assess exposure to musculoskeletal disorder (MSD) risk factors in non-routinized work. This is to provide information on revision of the new PATH tool and its reliability.

### Methods:

This was part of a study in which PATH method (Buchholz et al., 1996) was employed. From the version of PATH (Park et al., 2005), a version was newly revised and translated into Korean, as a paper checklist, and then to a digital version. The digital tool was completed by a software agent funded from Korea Occupational Safety and Health Agency. The agent conducted a project directed by a researcher (JKP) who provided a number of information for the agent. The information included ideas such as graphic icon of 18 PATH items, instrumental and operational functions in the field and laboratory, etc. Once the digital version was completed, we performed various tests including reliability of the new tool. For inter-rater reliability (inter-RR) test, methodological approach was similar to those published in a paper (Park et al., 2009). We did assess intra-rater reliability (intra-RR) as well. Study results on exposure assessment of MSD risk factors in hospital and hotel workers were published in different journals.

### Results:

Revision of the new version included: 1) language translated into Korean from English; 2) hand-held computer screen display changed from word to graphic mode; 3) functions further increased; 4) several items deleted or added (e.g., 'task' item was added). For inter-RR of the new tool, a total of 203 PATH observation pairs were determined for data analysis, and kappa coefficient ranged from 0 to 1.0 across the 18 PATH items. For intra-RR, a total of 372 observation pairs were determined and agreement percent ranged from 44% to 100%. Findings and considerations were extensively discussed.

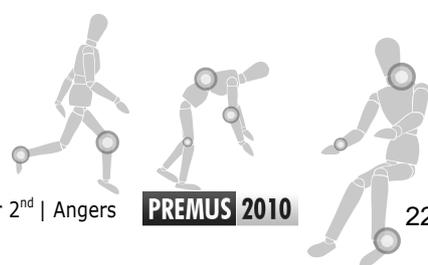
### Conclusion:

The new PATH tool, compared to the earlier one, was shown to improve in visual design and technical functions. For most PATH items, inter-RR of the new version was at least as high as that of the earlier, and intra-RR was acceptable as well. The study results suggest that the new PATH tool can characterize job tasks more effectively in ergonomic job analysis, and that it can be reliably utilized for exposure assessment of MSD risk factors in non-routinized work.

**Keywords:** Postures, Physical exposure, Health care workers, Exposure measurement methods

### References:

- Buchholz, B., V. Paquet, L. Punnett, D. Lee, S. Moir, PATH: A work sampling-based approach to ergonomic job analysis for construction and other non-repetitive work, *Applied Ergonomics*, 27(3): 177-187, 1996
- Park, J-K., J. Boyer, J. Tessler, G. Perez, L. Punnett, PHASE Project team, Exposure assessment of musculoskeletal disorder risk factors in hospital work: Inter rater reliability of PATH observations, *Proceedings of Human Factors and Ergonomics Society 49th Annual Meeting*, Orlando, USA, 2005
- Park, J-K. J. Boyer, J. Tessler, J. Casey, L. Schemm, L. Punnett, PHASE Project team, Inter-rater reliability of PATH observations for assessment of ergonomic risk factors in hospital work, *Ergonomics*, 52(7): 820-829, 2009



## RISK ASSESSMENT OF UPPER LIMB WORK-RELATED MUSCULOSKELETAL DISORDERS (UL-WMSDs) IN REPETITIVE TASKS BY OCRA METHOD

POURMAHABADIAN M., RAZZAGHINIA N., POURMAHABADIAN H.

Tehran University of Medical Sciences, Iran

### Aims:

In industrialized and developing countries, upper limb work-related musculoskeletal disorders (UL-WMSDs) are the most common form of occupational diseases. The aim of this study was to assess and analyze risk factors of upper extremity musculoskeletal disorders (UEMSDs) such as over force exertion, awkward posture, recovery period, over repetitiveness, etc. in different jobs as well due to high occurrence of UEMSDs in the largest manufacturer of various light vehicle axels and transaxles in Iran.

### Methods:

In order to prevent UL-WMSDs, the Occupational Repetitive Actions (OCRA) was applied to obtain an integrated assessment of the various risk factors, classify different jobs and suggest ergonomic designing solutions. Four data gathering methods including Observational, Interview, Nordic Musculoskeletal Questionnaire (NMQ), and OCRA were utilized. All 70 male workers occupying in 4 various job groups (70 tasks) in the largest manufacturer of various light vehicle axels and transaxles located in the west of Tehran were studied.

### Results:

The results of OCRA index in this study showed that the percent of work tasks lain in low, moderate, and high-risk level of were 40%, 53%, and 7%, respectively. Also, Significant relationship was found between four job groups including machinists (in 9 categories), welders, pre and final assemblers in ANOVA statistical test for right and left hand ( $F = 1.99$ ,  $p = 0.04$ ;  $F = 4.1$ ,  $p = 0.000$ , respectively) through OCRA method. In addition, it is observed that highest risk level of UEMSDs is belonging to final assemblers and pre-assemblers, respectively. No significant relationship was found between OCRA index and NMQ results. But significant relationship was found between reported pain in shoulder ( $t = 2.29$ ,  $p = 0.0$ ) and elbow ( $t = 2.83$ ,  $p = 0.006$ ) with age as well as with smoking habit ( $\chi^2 = 7.00$ ,  $p = 0.008$ ). Furthermore, the highest incidence of distal upper extremity was allocated to the wrist and shoulder in this study.

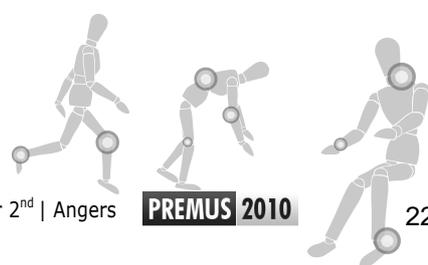
### Conclusion:

The OCRA method could be accounted as a useful method for evaluating risk factors of UEMSDS in repetitive tasks of the light vehicle axels manufacturing. Because, by obtaining the risk levels through this method, it is possible to determine the levels of control measures for UL-WMSDS in which jobs and tasks will be assessed and prioritized at the beginning of preventive measures program. In addition, this method provides for interaction between job and machinery designers as well as ergonomists in the design of work processes and workplaces.

**Keywords:** Intervention studies, intervention methods, Upper limb

### References:

- Occhipinti E. A concise index for the assessment of exposure to repetitive movement of the upper limbs. *Ergonomics*. 1998;41:1261-1289.
- Colombini, D., Occhipinti, E. Preventing upper limb work-related musculoskeletal disorders (UL WMSDS): New approaches in job (re)design and current trends in standardization. *Applied Ergonomics*. 2006;37:441–450.
- Grieco A. Application of the concise exposure index (ocra) to task involving repetitive movement of the upper limbs in a variety of manufacturing industries: preliminary validations. *Ergonomics*. 1998;41:1347-1356.



## RISK EVALUATION OF DEVELOPING DISTAL UPPER EXTREMITY DISORDERS BY STRAIN INDEX METHOD IN AN ASSEMBLING ELECTRONIC INDUSTRY.

POURMAHABADIAN M., SADEGHI-NAEENI H.

Tehran University of medical sciences, Iran

### Aims:

The strain index (SI) is a substantial advancement and has been devised to analyze ergonomic risks for distal upper extremity (DUE) disorders. This semi-quantitative tool allows for the measurement of hazards and does not require unduly lengthy training to begin to use it accurately. Uses of the strain index include analysis of a current job to assess whether it is safe or hazardous, quantification of the risks, and assistance in the initial design of a job or in the redesign of a job. The aim of this study was to assess and analyze risk of developing DUE disorders in different jobs as well as hazard classification in an assembling electronic industry through SI method.

### Methods:

In this study 69 electronic assembler workers through 35 jobs and 25 job groups of single task were chosen for SI assessment (multiple tasks is not considered and accounted in this method). Also, DUE disorders prevalence, work-related absenteeism and turnover extracted from SI results were compared and assessed by those obtained by Nordic musculoskeletal questionnaire (NMQ).

### Results:

The findings of this study showed that more than 50% of investigated jobs are categorized as "hazardous" and there is a significant difference between SI mean in hazardous and safe jobs ( $p < 0.0001$ ). In addition, significant difference was found between prevalence of DUE disorders in "safe" and "hazardous" jobs ( $p < 0.049$ ). But, no significant difference ( $p = 0.3$ ) was obtained between mean absenteeism in "safe" and hazardous jobs. Also, no significant difference statistically was found between turnover in "safe" and hazardous jobs ( $X^2 = 0.133$ ,  $p = 1$ ) and high prevalence of DUE disorders is due to low turnover rate of workers.

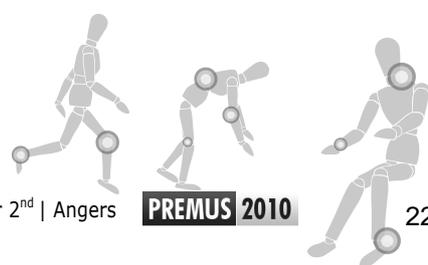
### Conclusion:

The findings of current study showed that 20 jobs were hazardous and 15 jobs were safe. Results of statistical test clearly revealed that there is a significant difference between mean SI in hazardous and safe jobs. Also significant difference was observed between DUE disorder prevalence in safe and hazardous jobs. Comparison between mean SI data and DUE disorders, work-related absenteeism and turnover showed that there was a good association between SI data and DUE disorders prevalence results obtained by NMQ questionnaire. Thus, it can be concluded that the SI has a good validity in assessing of DUE disorders risk assessment.

**Keywords:** Exposure measurement methods, personal risk factors for MSD, other

### References:

- Moore JS, Garg A. Upper extremity disorders in a pork processing plant: relationships between job risk factors and morbidity. *Am Ind Hyg Assoc J.* 1994 Aug; 55(8):703-715.  
Knox K, Moore IS. Predictive validity index in turkey processing. *1.OEM*, 2001; 43(5): 451-462.  
Rucker N, Moore JS. Predictive validity of the strain index in manufacturing facilities. *Appl Occup Environ Hyg.* 2002 Jan; 17(1):63-73.



## PREVENTION OF MSDS: SELF-PERCEPTION IN TIME AND SPACE WITH DIGITAL SIMULATION OF WORK.

NAHON P., GUILLOUX V., FORTINEAU E.

*Solutions Productives, France*

### Aims:

The ergonomist presents an interpretation of work situations with risk of MSDs to help people involved in a project to perceive and understand the phenomena involved in the impact of work on health/effectiveness.

How to characterize work situations presenting risks of MSDs

The main determinants of work situations at risks of MSDs are biomechanical constraints and the time window available to the operator to perform his task by integrating the various sources of unpredicted incidents.

Based on a 4 dimensional flow simulation, the ERGO 4D approach, developed by Solutions Productives, integrates the variability related to an activity. It makes it possible to realise and visualise the dynamic evolution of the room for manoeuvre in time, a main risk factor for MSDs (enhancement of biomechanical constraints) in an area where the classical tools provide only a static snapshot of the phenomenon.

As its contribution towards understanding and persuasion in ergonomic interventions was presented at the SELF conference, our aim is to illustrate the contribution of this approach in the representation of real spatial and temporal room for manoeuvre.

### Results:

Self-representation in time and space: what is the contribution?

For operators : The ERGO 4D approach facilitates operators' expression by representing visually the phenomena that they feel in their bodies ("it goes too fast") but that are complicated to express in words.

For design engineers: Variability is often underestimated during the design stage.

The difficulty for designers consists above all in grasping the reality in all its complexity, beyond the classical heuristic reasoning.

### Conclusion:

Two limitations:

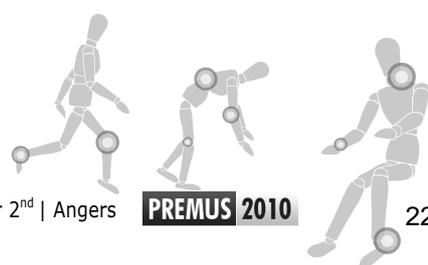
Social: "I am not paid for that", "I am not going to run the risk of wasting time for a 'one-off' difficulty

Cognitive: variability, an epiphenomenon, is not considered to be a structural starting point, but as a residual problem that is dealt with later, at the time of installation.

The ERGO 4D approach sheds light on the possible room for manoeuvre in time and space and the impact on the health and effectiveness of the workforce by anticipating the likely functioning of equipment: immediate and delayed effects (e.g. after several hours of production), technical and organisational leads for improvement.

Variability becomes a "valid" subject, and its incorporation at the design stage overcomes the conditions with a less damaging and more effective movement

**Keywords:** Exposure measurement methods, intervention studies, intervention methods



**OCCUPATIONAL REPETITIVE ACTIONS INDEX (OCRA) APPLICATION FOR A JOB ROTATION PLAN**

SATO T.O., KOMATSU M.O., MARTINS K.C., FRANCISCO K.R., ALEM M.E.R.

*Physiotherapy Department, Federal University of São Carlos, São Carlos, São Paulo, Brazil.***Aims:**

To evaluate the risk factors associated with different work tasks based on the calculation of the OCRA to propose an effective job rotation plan intended to prevent musculoskeletal disorders.

**Methods:**

Three examiners applied the OCRA index in twelve female workers in ten different tasks. The most often repetitive tasks in manual packing of small products from a manufacturing company were identified and evaluated. The evaluations took place during working hours and at the production line. Each task was classified as low (OCRA <0.75), medium (OCRA >0.75 or <4.0) or high risk (OCRA >4.0) [Occhipinti, 1998].

**Results:**

Table 1 shows that in some tasks, e.g. D2, F and J, the exposure was not symmetrical. Only one task (H) was classified as low risk and one (A) as medium risk. All the other tasks were classified as high risk by the OCRA index.

Table 1. OCRA index and risk classification for each task.

Tasks	OCRA index		Risk classification	
	right arm	left arm	right arm	left arm
A	1.71	0.85	medium	medium
B	10.49	9.32	high	high
C	8.78	7.31	high	high
D1	6.05	10.59	high	high
D2	4.56	2.28	high	medium
E1	5.49	9.18	high	high
E2	5.92	4.94	high	high
F	4.15	2.24	high	medium
G	17.90	5.43	high	high
H	0.53	0.53	low	low
I	15.30	6.84	high	high
J	10.86	1.41	high	medium

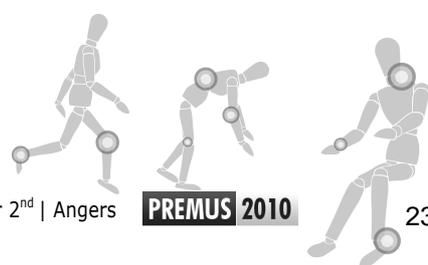
**Conclusion:**

The job rotation helps reducing musculoskeletal overload by altering the biomechanical load, and also may increase employee job satisfaction. A proper rotation interval is one that minimizes the potential for worker injury and can be implemented realistically. Tharmmaphornphilas and Norman (2004) show that a two hours rotation interval presents almost all possible benefits that could be obtained through job rotation. Therefore, the proposed rotation plan should be implemented in two hours periods with succeeding tasks differing in risk, as much as possible in an order of high-low-medium or low-high-medium risk tasks. However, some disadvantages of job rotation should be mentioned: the adaptation to each task would be hardly achieved and the worker's specialization level would be reduced. Therefore, local managers should evaluate the costs and benefits associated to the job rotation implementation, considering the time spent with workers' training and the financial burden and social losses caused by sick leave as a consequence of musculoskeletal disorders.

**Keywords:** Work organization, exposure measurement methods, upper limb

**References:**

- Occhipinti E. OCRA: a concise index for the assessment of exposure to repetitive movements of the upper limbs. *Ergonomics*. 1998;41(9):1290-1311.
- Tharmmaphornphilas W, Norman BA. A quantitative method for determining proper job rotation intervals. *Annals of Operations Research*. 2004;128(1-4):251-266.



## WRULMSDS RISK FACTORS IDENTIFICATION: RISK ASSESSMENT CONTRIBUTES IN AN AUTOMOTIVE PLANT

SERRANHEIRA F., SOUSA-UVA A.

ENSP-UNL, CIESP-Centro de Investigação e Estudos em Saúde Pública, 1600-560 Lisboa

### Aims:

Work-related upper musculoskeletal Disorders (WRULMDs) are widespread in the industrial field associated with important occupational disability costs.

WRULMSDs risk assessment is often done with methods that are developed to enable (i) the identification of occupational hazards and (ii) to do WRULMSDs risk evaluation. Occupational risk factors identification is one of the first steps in risk assessment, but how important is that on integrated WRULMSDs risk assessment method selection?

### Methods:

Workstations previously classified (OCRA checklist) with high risk scores (n=152) were reevaluated. Those still presenting moderate/high scores (n=71) on WRULMSDs (OCRA score  $\geq 16,5$ ) were de novo evaluated using two risk filters (HSE and OSHA) and three other methods: RULA; SI; and HAL. Work at these workstations is videotaped at least in two complementary perspectives. Methods analysis is done by multivariate linear regression modelling for the effect of each independent variable on the final score (R-square-stepwise). The methods comparison (final scores) is done by means of Spearman correlations.

### Results:

Risk factors identification denotes discrepancy between HSE and OSHA results at a video analysis. OSHA risk factor identification has a better predictive validity results in force (0,80) and HSE in posture (0,75). Exposure to vibrations has similar predictive validity with both filters (OSHA=0,76; HSE=0,82) and repetitivity is better evaluated with OSHA (0,53).

Analysis of methods (final scores) evidence a distinct risk assessment process.

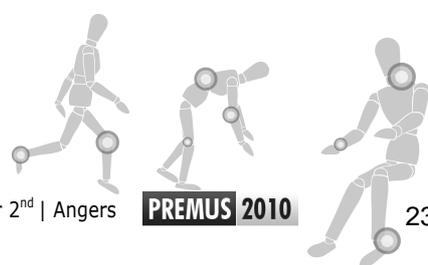
Final scores were different with each of the four methods and showed disagreement among high-risk workstations. At OCRA high risk workstations (n=71) only 31 had identically rating using the SI (Kappa=0,23) and only 7 by the RULA (Kappa=0,04). OCRA has a moderate correlation (p

### Conclusion:

As expected, results point to significant divergences at integrated methods risk assessment processes but some accordance in single risk factors evaluation. If there is no evidence for choosing a specific method to evaluate WRULMSDs risk in a particular workstation, the identification of workplace risk factors may contribute to the WRULMSDs risk assessment method choice.

These results emphasized the importance of a previously workplace analysis at all risk assessment WRULMSDs tool selection.

**Keywords:** Exposure measurement methods, Intervention methods, Upper limb



## PHYSICAL EXPOSURE

### THE PERSONAL LOAD ASSISTIVE DEVICE (PLAD) WORKS: A REVIEW OF CURRENT FINDINGS

STEVENSON J.M., GRAHAM G.B., SADLER E.M., ABDOLI-E M., AGNEW M.J.

*Queen's University, Kingston, Ontario, Canada*

#### Aims:

The aim was to determine if an on-body personal lifting assistive device (PLAD) can reduce erector spinae (ES) muscular activity during lifting tasks and forward bending tasks. The PLAD is designed with elastic elements acting parallel to the ES that are anchored at the shoulders, under the feet with an extended lever arm at the pelvis. The specific goals were to investigate its effectiveness under different conditions: loads lifted, style of lift, lift symmetry, during fatigue tasks, repetitive tasks, and in field conditions.

#### Methods:

In each sub-study, a minimum of 10 men and 10 women participated. EMG electrodes were placed over the ES at L3 and T9 with EMG recorded over different abdominal and leg muscles, depending on the study. Either maximal EMG efforts or reference postures were used to normalize EMG for lifts from floor to waist height. For some studies, position sensors were used to determine either L4/L5 moments or trunk kinematics. For individual lifts, EMG was reported only during the up-phase of lifts. For fatiguing lifts, EMG amplitudes and frequencies were captured during a static holding task at 5 minute intervals throughout the 45 minute lifting task. For field studies, ES activity was recorded for one hour during repetitive static holding or lifting tasks. ANOVAs were conducted for EMG activity L3 and T9 plus other objective and subjective variables based on the experiment.

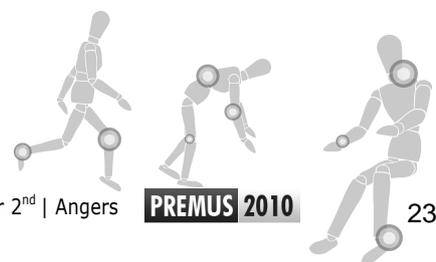
#### Results:

Across all studies, the results revealed that PLAD had a significant effect on ES activity, regardless of sex or condition ( $p= 0.05$  to  $p=0.001$ ). For tasks involving single lifts, the percent different in EMG amplitude reduction varied from 14.0% to 27% with L4/L5 moments reduced by 13.2% to 19.4%. For fatiguing tasks, the PLAD reduced ES amplitudes by 91% and 104% over No-PLAD for women and men respectively with EMG frequency shifts showing less fatigue with PLAD ( $p=0.001$ ). During field trials, there was a 20% reduction in EMG activity. Regardless of the study, the PLAD showed a significant reduction in the need for ES muscular activity.

#### Conclusion:

In conclusion, regardless of gender, load lifted, style of lift, lift symmetry, fatigue or type of task, the PLAD was effective. What remains to be seen is PLAD's impact on spinal stability and how it changes lifting technique. If effective in these areas, then it should be tested in industrial plants for its effectiveness at reducing low back disability.

**Keywords:** Biomechanics, Muscle activity, Back, Low back



## MANUAL MATERIALS HANDLING: EXPERT HANDLERS USE DIFFERENT LIFTING STRATEGIES THAN NOVICES

PLAMONDON A., DELISLE A., DENIS D., LARIVIÈRE C., ST-VINCENT M., SALAZAR E., GAGNON D., NASTASIA I.

*Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST), Montréal, Québec, Canada; Faculté d'éducation physique et sportive, Université de Sherbrooke, Sherbrooke, Québec, Canada*

### Aims:

Manual material handling (MMH) is considered a hazardous activity, particularly for the lower back. Training is one common avenue of prevention. However, recent studies are challenging the effectiveness of techniques taught in training programmes which often fail the conversion to the workplace practices. On the other hand, ergonomic observation studies show that handlers with several years of experience have developed methods that are different from novice workers and that these methods can serve to improve the content of the training programmes (Authier et al., 1996). The purpose of this study was to further compare the techniques of expert and novice manual handlers.

### Methods:

Fifteen expert handlers (years of experience: Mean = 15.4 yrs, SD = 9.3) and 15 novice workers (years of experience: Mean = 0.5 yr, SD = 0.4), all men, were invited to perform series of box transfers under conditions similar to those of large distribution centres. The tasks consisted of lifting four different types of box (3 boxes of 15 kg and one of 23 kg) from a conveyor to a hand truck. The subjects had to perform a total of 128 lifts during the experimental session. Physical fatigue was controlled by allowing frequent rest periods. The handlers were free to choose their lifting techniques and there was no restriction on how to move. The only instruction given to the subjects was to handle the load the way they usually do. Low back postures and L5/S1 moments (back loading) were quantified using a dynamic 3-D linked segment model (Plamondon et al., 1996).

### Results:

L5/S1 extensor moments were not significantly different between expert and novices handlers as opposed to the torsion moments which were different ( $P < .05$ ). During the lifting phase, experts flexed significantly less ( $P < .05$ ) their lumbar spine than novices at the instant of the peak resultant moment (experts: Mean =  $54^\circ$  SD =  $11^\circ$ ; novices: Mean =  $66^\circ$  SD =  $15^\circ$ ). Moreover, experts bent significantly more their knees and were closer to the load than novices. Similar trends were found during the deposit phase.

### Conclusion:

These results indicate that expert handlers stay inside a margin of safety which protects their spine by avoiding extreme flexion posture. For training programmes, these results may alert instructors to put more emphasis on the role of keeping a margin of safety for the spine during MMH tasks.

**Keywords:** Biomechanics, Postures, physical exposure, Personal risk factors for MSD

### References:

Authier M, Lortie M, Gagnon M. Manual handling techniques: Comparing novices and experts. *International Journal of Industrial Ergonomics*. 1996;17: 419-429.  
Plamondon A, Gagnon M, Desjardins P. Validation of two 3-D segment models to calculate the net reaction forces and moments at the L5/S1 joint in lifting. *Clinical Biomechanics*. 1996;11:101-110.



**PHYSICAL WORKLOAD ON NECK, SHOULDER AND UPPER ARM IN VARIOUS TYPES OF WORK**

HANSSON G.Å., BALOGH I., OHLSSON K., GRANQVIST L., NORDANDER C., ARVIDSSON I., ÅKESSON I., UNGE J., RITTNER R., STRÖMBERG U., SKERFVING S.

*Division of Occupational and Environmental Medicine, Lund, Sweden*

**Aims:**

Physical workload, in terms of constrained postures, repetitive movements, high muscular load and lack of recovery, are known risk factors for developing UEMSDs. One reason for the limited effect of preventive measures may be that the prevailing methods for assessing physical workload – questionnaires and observer ratings – are not sufficiently valid and precise for deriving quantitative exposure-response relationships as a base for prevention. The aim was to identify suitable exposure measures, by exploring the correlations between, and range of, various measures derived from technical measurements recorded at the workplaces.

**Methods:**

Inclinometers, based on tri-axial accelerometers, were used for recording of head flexion/extension and upper arm elevation. Various percentiles of the angular, as well as the angular velocity distributions, were used to characterise the exposure. EMG was used for recording of the muscular activity of the trapezius muscle. Muscular activity was normalised to the EMG derived during maximal voluntary contractions (MVE). Fraction of time with muscular rest/recovery and various percentiles of the amplitude distributions were used to describe the load. Measurements were performed in more than 40 types of work; varied and repetitive industrial work, and varied and constrained office work.

**Results:**

Many exposure measures, especially adjacent percentiles, and all movement measures, were highly correlated. For head flexion/extension the 1st (representing extension) and the 90th percentile (representing flexion) were uncorrelated and thus suitable as independent risk factors in exposure/response models. Arm elevation may be described by one percentile (e.g. the 99th). One velocity measure (e.g. the 50th percentile) may be sufficient to describe the movements of the head and arm. Although the fraction of muscular rest/recovery and the 90th percentile (peak load) were correlated, they are relevant to keep as two different exposure-dimensions, since they represent different patho-mechanisms. For all exposure measures there were great variations due to type of work: head: flexion 9° to 63°, extension -39° to 4°, movements 2.3 to 33 %s; arm: elevation 49° to 124°, movements 3.0 to 103 %s; trapezius: muscular rest/recovery 0.8% to 52% of time, peak load 3.1% to 24% MVE.

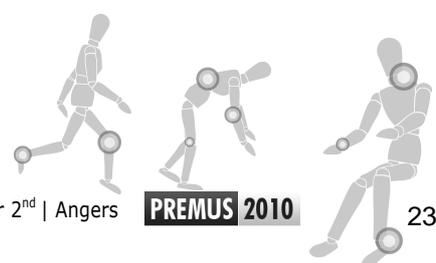
**Conclusion:**

The multidimensional character of the exposure – postures and movement, as well as muscular rest/recovery and peak load – has to be considered. The presented measures of the main physical workload risk factors for developing UEMSDs are appropriate candidates for describing exposure-response relationships in epidemiological studies.

**Keywords:** Muscle activity, Postures, physical exposure, Exposure measurement methods.

**Reference:**

Hansson G-Å, Balogh I, Ohlsson K, Granqvist L, Nordander C, Arvidsson I, Åkesson I, Unge J, Rittner R, Strömberg U, Skerfving S. Physical workload in various types of work; part II: Neck, shoulder and upper arm. *Int J Ind Ergon*. In press



## ASSESSMENT OF PERFORMANCE AND PHYSICAL DEMANDS WHEN USING A PROTOTYPE COURIER DELIVERY TRUCK

MARSHALL J., HURLEY K., WELLS R.

*Centre for Research Expertise for the Prevention of Musculoskeletal Disorders (CRE-MSD), Waterloo, Canada - Department of Kinesiology, Faculty of Applied Health Sciences, University of Waterloo, Ontario, Canada*

### Aims:

To compare performance, physical demands and mechanical loading when using a standard courier delivery truck and a prototype electrically powered courier truck.

### Methods:

Because of variability of routes and loads, assessment was made using a standard set of packages. The simulation was based on the courier company's loading data and route rides and defined the size of boxes, weights of boxes, number of boxes per stop, door the driver had to use (side or back) and whether a cart was used for delivery. A repeated measures study design was used and the same ten courier drivers used both vehicles in a randomized order over 18 stops. Drivers' postures and times were taken from four surveillance video cameras placed in and around the trucks. Surface electromyography (EMG) was collected bilaterally for upper trapezius, extensor digitorum and lumbar erector spinae sites. Behaviour was analyzed using commercial software (NOLDUS Observer<sup>TM</sup>, Netherlands) which was used to extract synchronized EMG and motion data for driving, loading and unloading activities. This allowed assessment of tasks, times, postures and the number and location of lifts. Posture and load data were used to calculate low back loading using a biomechanical model and the loads and postures used were compared to the weights listed in the ACGIH lifting TLV (<http://www.acgih.org/tlv>).

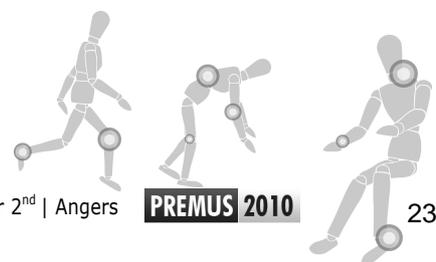
### Results:

Multiple measures showed improved performance and loading with the prototype vehicle (all  $p < 0.05$ ). The average time spent retrieving and placing packages inside the truck was 1.4 times greater with the standard truck. Package handling decreased and the average number of lifts and lowers with the standard truck was 1.6 times greater. The average number of lifts and lowers above the ACGIH lifting guidelines was 1.7 times higher for the standard truck and the average number of lifts and lowers with spinal compression  $> 3400$  N was 1.6 times higher. The average estimated cumulative compression was 1.6 times greater with the standard truck.

### Conclusion:

The prototype truck decreased physical demands and mechanical loading and increased the drivers' performance. Power doors and "kneeling" features on the prototype reduced the duration of time required to load and unload packages, reduced the double handling of packages, eliminated the lifting and lowering of the carts out the rear door, and eliminated the awkward handling of packages or staging of packages while opening/closing and (un)locking the rear and side doors. The feedback from participating courier drivers supported these results.

**Keywords:** Biomechanics, Intervention studies, Intervention methods



## EFFECT OF LIFTING CONDITION ON THE ANTICIPATORY MUSCLE RECRUITMENT PRIOR TO LIFTING

YOON J.

*Occupational and Industrial Orthopaedic Center (OIOC) NYU Hospital for Joint Diseases, New York, NY, USA*

### **Aims:**

Anticipatory muscle recruitment immediately before a voluntary movement is required to stabilize the proximal joints and to initiate the movement. Anticipatory muscle recruitment was extensively studied in the finger pointing and jump landing tasks. Anticipatory muscle recruitment during lifting has not been explored. Improper pre-lifting muscle recruitment would affect the efficiency of performance and the joint stability. The aim of this study was to investigate the effect of lifting pace, box weight and target size on the intensity and variability of anticipatory muscle recruitment and on the range of motion (ROM) during pre-lifting period.

### **Methods:**

Thirty nine healthy subjects performed a total of 24 lifts (3 lifting trials of 2 lifting paces, 2 box weights, and 2 target sizes), from waist to shoulder level. Kinematical data and electromyography (EMG) of seven trunk muscles (trapezius, biceps, thoracic and lumbar elector spinae (TES and LES), rectus abdominalis (RA) and internal and external obliques (IO and EO) were collected. The effect of precision, weight and pace on lifting speed was analyzed. Pre-lifting period was defined between the moments of hand contact and box take off. Repeated measures MANOVA performed.

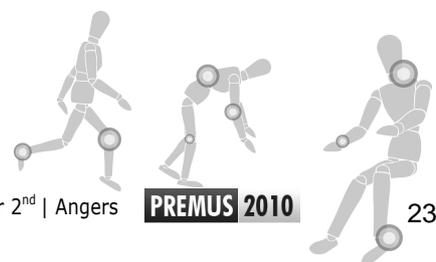
### **Results:**

Pre-lifting trapezius, biceps, TES and LES increased at maximal pace and with heavier weight. No significant effect was observed in the pre-lifting RA. EO and IO increased with heavier box. No effect of target size was observed on any of pre-lifting EMG. The inter-trial variability in pre-lifting trapezius, biceps and TES increased at maximal pace and only TES increased with heavier weight. Pre-lifting duration shortened at maximal pace. Pre-lifting elbow ROM increased at maximal pace. Pre-lifting shoulder ROM was affected by pace and weight.

### **Conclusion:**

Anticipatory muscle recruitment is a feed-forward control against the perturbation from voluntary segmental movement and is an acquired motor strategy through the long process of motor learning. Faster lifting pace and heavier box weight increased the demand of anticipatory muscle recruitment and the variability in performance. This suggests that different motor strategies may be endorsed for different lifting conditions. Since improper pre-lifting muscle recruitment can be a cause of the back injury or the inefficient performance, the anticipatory muscle recruitment of skilled worker under various lifting conditions such as unknown box weight needs to be studied in the future. These findings underscore the importance of variability of pre-lifting motor strategies under different lifting conditions.

**Keywords:** Mechanism of pain and tissue injury, Muscle activity, Back, low back



## THE IMPACT OF MUSCULAR AND CARDIOVASCULAR CHANGES ON THE DEVELOPMENT OF SELF-REPORTED PHYSICAL DISCOMFORT DURING A SIMULATED STANDING WORK TASK

ANTLE D.M.<sup>1</sup>, CÔTÉ J.N.<sup>1</sup>, VÉZINA N.<sup>2</sup>, MESSING K.<sup>2</sup>

<sup>1</sup> Department of Kinesiology and Physical Education, McGill University, Montréal, QC, Canada - <sup>2</sup> Centre de recherche interdisciplinaire sur la biologie, la santé, la société et l'environnement, Université du Québec à Montréal, Montréal, QC, Canada.

### Aims:

Workplace and laboratory research suggests prolonged standing leads to discomfort in the feet, lower limbs and trunk. Furthermore, long-term exposure to standing work is associated with the development of musculoskeletal disorders in the trunk and development of vascular disorders in the lower limbs. However, there is a lack of dose-response information related to prolonged standing work and the onset of muscular and vascular outcomes.

### Methods:

A total of 10 female participants between 19 and 29 years of age were asked to displace spherical objects between two containers for a 32 minute simulated working period. Participants were outfitted with surface electrodes to collect electromyographic (EMG) data from the upper limb and trunk, and Laser Doppler Flowmetry (LDF) electrodes on the lower limb to collect cutaneous blood flow data. Every 4 minutes the researchers collected EMG and LDF readings, as well as brachial and ankle blood pressure, heart rate, lower limb skin temperature, and participant ratings for localized discomfort.

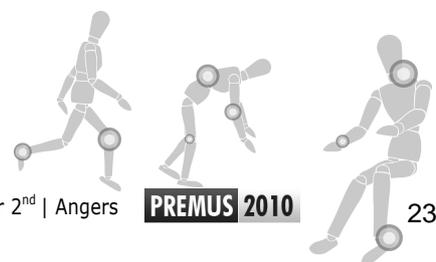
### Results:

Early results show that all but 1 participant reported increased discomfort in the feet, with the change in discomfort being statistically significant among the group ( $p < 0.05$ ). LDF measures were significantly increased ( $p < 0.05$ ) in the lower limb by approximately 30% and by 60% in the feet. A multiple regression model with standing time and foot-LDF shows a strong relationship with reported discomfort. Mean arterial pressure in the leg showed a nearly significant ( $p = 0.101$ ), but relatively small average increase of 5%. Some subjects showed increased muscle recruitment in the trunk and upper limb, but no significant differences with baseline were found. There were also no consistent reports of discomfort in the trunk and upper limb among the participants.

### Conclusion:

These results show that early musculoskeletal discomfort in the feet and lower limbs may be a function of blood pooling in these regions. Therefore, specific interventions to improve comfort may require reducing blood pooling by changing working posture. Since the literature indicates that other musculoskeletal and vascular symptoms may develop over longer periods, these should be considered as well. These results are part of a larger ongoing research project on the impacts of standing, seated and sit-standing work. These investigations include laboratory research and ergonomic intervention research at an enterprise. This ensures 1) work organization and contextual considerations are included in laboratory simulations, and 2) physical, as well as psychological and organizational components, are considered in workplace adaptations.

**Keywords:** Mechanism of pain and tissue injury, Postures, physical exposure, Lower limb.



## COMPARING WHOLE BODY VIBRATION EXPOSURES BETWEEN A CAB-OVER AND CONVENTIONAL TRUCK

BLOOD R.P., RYNELL P.W., JOHNSON P.W.

Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, WA, USA

### Aims:

The aim of this study was to compare whole-body vibration (WBV) exposures between a cab-over and non-cab over/conventional flatbed truck. Recent research has shown that there is a dose response pattern with an increased risk of low back pain associated with working as a professional driver[1]. Recent research has also shown that WBV exposures differ based on the type of road and design of the seat[2].

### Methods:

Using a repeated measures design and a standardized test route, whole body vibration exposures were compared when thirteen experienced flatbed truck drivers drove two vehicles, 1) a European style flatbed truck where the drivers were situated directly over the front wheels (cab-over design) and 2) and a North American style flatbed truck where the cab was situated behind, rather than over, the front wheels. Both vehicles were analyzed with the stock seats that came with the vehicles and the 15 minute standardized test route consisted of a section of freeway and two sections of city streets. A tri-axial seat pad accelerometer was mounted on the driver's seat and a second tri-axial accelerometer was securely mounted on the floor of the vehicle, speed was collected using a GPS device. A WBV data acquisition system was used to collect raw (Sed) and time weighted average (Aeq, VDV) tri-axial WBV measurements at 1280 Hz from the seat and floor.

### Results:

When compared to vibration measurements at the floor, the seats in both vehicles were shown to significantly attenuate WBV exposures. As shown in Table 1 below, when comparing vehicle types, there were significant differences in WBV exposures with the cab-over design flatbed having higher WBV exposures.

**Table 1: WBV exposures by vehicle type (n=13).**

	Seat			Floor		
	Cab-Over	Non Cab-Over	p-value	Cab-Over	Non Cab-Over	p-value
<b>A<sub>w</sub></b>	0.67 (±0.03)	0.49 (±0.01)	<.0001	0.74 (±0.04)	0.58 (±0.03)	0.0009
<b>VDV</b>	14.5 (±0.81)	12.3 (±0.67)	0.0015	16.2 (±0.89)	13.7 (±0.83)	0.0499
<b>S<sub>ed</sub>*</b>	0.50 (±0.05)	0.34 (±0.01)	0.0089	N/A	N/A	-

\* - S<sub>ed</sub> not calculated on the floor

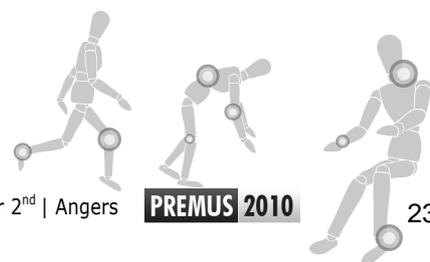
### Conclusion:

Long-term WBV exposure has been linked to occupationally-related low back pain. When selecting vehicles for professional drivers it is important that employers consider the associated WBV exposure differences between different types of vehicles. The results of this study indicated that, relative to vehicles where the cab was situated over the front wheels, vehicles with a cab situated behind the front wheels may decrease occupational WBV exposures.

**Keywords:** Mechanism of pain and tissue injury, Vibrations, driving, Exposure measurement methods

### References:

IJ Tiemessen, CT Hulshof, MH Frings-Dresen (2008). Low back pain in drivers exposed to whole body vibration: analysis of a dose-response pattern. *Occ and Env Med* 65:667-675.  
 RP Blood, JD Ploger, MG Yost, RP Ching, PW Johnson (2010). Whole body vibration exposures in metropolitan bus drivers: A comparison of three seats. *Journal of Sound and Vibration* 329:109-120.



## THE DEVELOPMENT OF A STAGE-I RISK FIL FOR PHYSICAL WORKLOAD

KRAKER DE H. , DOUWES M., COMMISSARIS D.A.C.M.

*TNO Quality of Life, Hoofddorp, The Netherlands*

### **Aims:**

The application of stage-II risk assessment tools, like the NIOSH lifting equation, is time consuming. Therefore, the risk assessment process to assess all possible MSD risks (e.g. manual handling, pushing, pulling, postures, repetitive load, etc.) for all work tasks takes too much time, especially for SME's. To make the risk assessment process more efficient, there is a need for an easy, quick to apply stage-I risk filter that identifies possible hazards with respect to physical load and indicates on which aspects a stage-II risk assessment tool should be applied.

The aim of the study was to develop a stage-I risk filter (checklist) for employers to detect the possible presence of MSD risks. The result from this tool makes clear whether a more detailed assessment is needed and which stage-II method should be applied.

### **Methods:**

The development was initiated by defining seven main aspects of physical load and selecting acknowledged stage-II risk assessment tools that are widely used in the Netherlands for those seven aspects. Simple questions were formulated from the stage-II methods with the aim to fit the core items of the stage II methods in simple and short questions. After finishing the first concept of the stage-I tool, risk assessments were performed with both the stage-I and stage-II tools in order to find possible differences and improve the stage-I tool where necessary. After assessing tasks for all aspects of physical load and adjusting the stage-I tool according to the differences, a final web application will be developed.

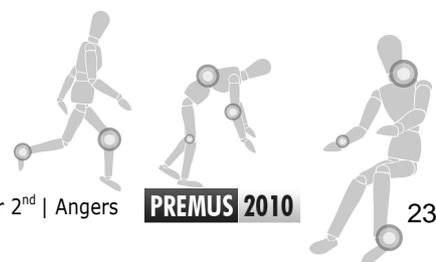
### **Results:**

First results: when comparing the stage-I tool with the stage-II instrument for hand arm tasks, the final score in terms of green (no increased risk), orange (increased risk) and red (seriously increased risk) showed agreement for four out of five tasks assessed.

### **Conclusion:**

The development of a stage-I risk filter is an effort to help employers in the process of risk assessment regarding physical load. It remains unclear if this tool will achieve this goal. To see if this tool works in practice, the tool will be made freely available, employers will be encouraged to use it and experiences from employers using the tool will be evaluated.

**Keywords:** Exposure measurement methods, Early prevention



**PUSHING AND PULLING: A REVIEW OF DIFFERENT WORK SITUATIONS**

DESBROSSES K., MEYER J.P., DIDRY G.

*INRS, Vandoeuvre, France***Aims:**

The repeated action of whole-body pushing and pulling may induce development of musculoskeletal disorders (Hoozemans et al., 1998). A recent ISO standard (ISO 11228-2) recommends force limits during manual pushing and pulling with the aim of preventing these MSD. However, force measurement requires specific technical equipment (a force transducer), which many companies do not possess. In many cases, a model that converts measured force (in newtons) into loading weight (in kilogrammes), a parameter more easily monitored by companies, needs to be built. This study both demonstrates the importance of standardization and describes different work situations with their respective loading weight limit models.

**Methods:**

Various work situations (at hospitals, automobile companies, industrial bakeries, etc.) were investigated. Pushing and pulling forces exerted by employees to move mobile loads (meal trolleys, containers, etc.) were measured using electronic force transducers. In each work situation, employees were asked to push and pull a mobile unit loaded with different weight to establish a relationship between loading and exerted force. Initial force (start of movement) and continued force (during movement) were both analysed. Cardiac frequency was also recorded during all measurement sessions to evaluate the overall physiological strain caused by these pushing-pulling tasks. In addition, in some situations, electromyographic activity was recorded to evaluate level of muscular contractions.

**Results:**

Forces exceeded limits recommended by the standard in all work situations, in which the mobile unit was loaded with the usual weight. The slope of the ground or improper positioning of the handle grip greatly exacerbated pushing and pulling efforts. Overall physiological strain was considered high in some situations and heavy usage of lumbar and shoulder muscles was recorded (>40% of maximum activity, when exerting initial force).

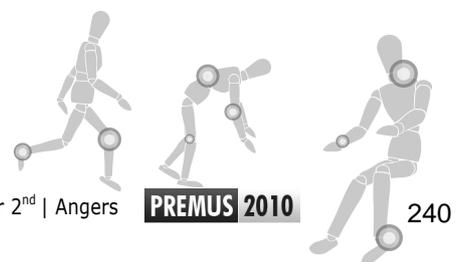
**Conclusion:**

Many work situations involve pushing and/or pulling a mobile unit. Measurements taken during the study demonstrate that forces exceed ISO standard recommendations. Such pushing-pulling tasks could therefore be risk factors contributing to development of musculoskeletal disorders. Consideration of the pushing-pulling force issue would therefore be essential for prevention of occupational health and safety risks. A new version of NF X35-109 French standard also considers this issue and includes, in addition to force limits, examples of maximum loading weights for different mobile units. Recent publication of the above two standards will probably assist designers and employers in better understanding forces involved in pushing-pulling tasks and thereby improving working conditions.

**Keywords:** Biomechanics, muscle activity, postures, physical exposure

**References:**

Hoozemans, M.J.M., van der Beek, A. J., Frings-Dresen, M.H.W., van Dijk, F.J.H., & van der Woude, L.H.V. Pushing and pulling in relation to musculoskeletal disorders: a review of risk factors. *Ergonomics*. 1998; 41 (6), 757-781., ISO 11228-2. *Ergonomics – Manual handling – Part 2: Pushing and pulling*. 2007., NF X35-109. *Ergonomics - Manual load handling for lifting, moving and pushing/pulling - Analysis methodology and threshold values*. 2009.



## BODY WEIGHT INFLUENCES LIFTING PERFORMANCE

HANDRIGAN G.A., PLAMONDON A., SIMONEAU M., TEASDALE N., CORBEIL P.

Groupe de Recherche en Analyse du Mouvement et Ergonomie - Université Laval, Québec, Canada

### Aims:

Obesity is associated with increased morbidity and also with increased risk of injuries (Pollack, et al. 2007). The objective of this pilot study was to evaluate the effect that body weight may have on lifting performance in a simulated working environment. The focus of this investigation is on postural constraints, particularly extreme flexions and trunk moments. We hypothesized that overweight workers will have larger trunk moments and will demonstrate protective strategies to reduce muscular efforts.

### Methods:

Initially, 30 male subjects were grouped on expertise (15 experts and 15 novices), for this pilot study they were also grouped according to their BMI, either as control BMI < 25 kg·m<sup>-2</sup> or overweight BMI >25 kg·m<sup>-2</sup>. When grouped by BMI and expertise, we had four groups i) novice control (n=9), ii) novice overweight (n=6), iii) expert control (n=5) and iv) expert overweight (n=10). The simulated working task consisted of a box transfer that involved lifting, moving and placing boxes of varying weights (15kg and 23kg) from the floor and stacking them. Movement analysis was performed with an 'Optotrak' motion capture system. Kinematic and kinetic data were entered into a 3D biomechanical model (Plamondon, et al. 1996) that estimates the net moments at the L5/S1 joint.

### Results:

The higher BMI group displayed greater moments at L5/S1 ( $P < .01$ , Fig. 1B). Novice overweight workers inclined their trunks similarly to expert 'normal weight' and 'over weight' workers, whereas 'normal weight' novice workers showed greater inclination (BMI vs. Expertise interaction  $P < .05$ , Fig. 1A). The higher BMI group had a longer minimal horizontal distance between the joint L5/S1 and the box ( $P < .08$ ).

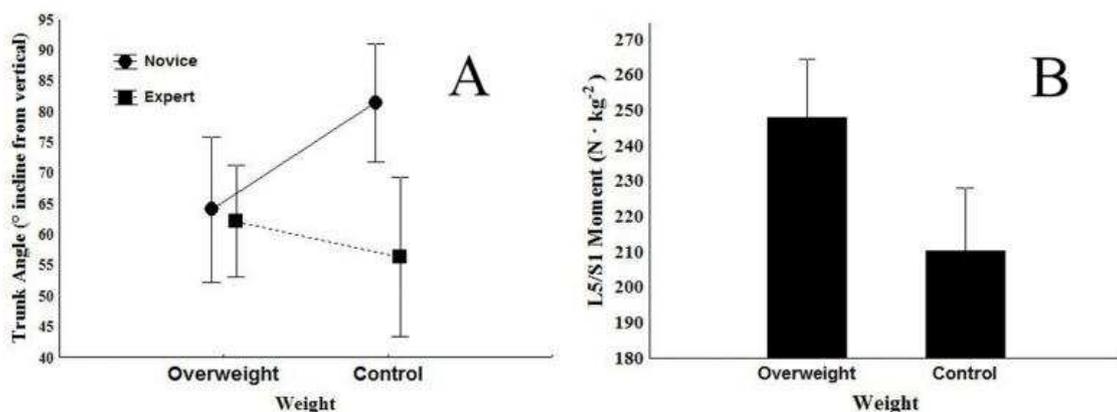


FIGURE 1: A) Trunk angle inclination, B) L5/S1 Moment. Values are mean  $\pm$ 95% C.I.

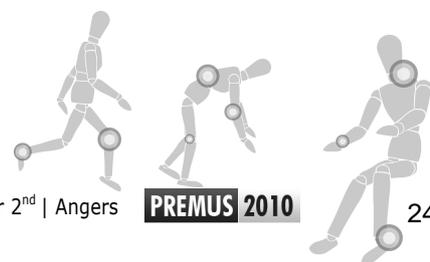
### Conclusion:

This experiment was not designed to specifically study overweight workers but these results indicate that overweight was a factor in the loading of the back and protective strategies may be present.

**Keywords:** Biomechanics, Postures, Physical exposure, Personal risk factors for MSD

### References:

- Plamondon A, Gagnon M, Desjardins P. Validation of two 3-D segment models to calculate the net reaction forces and moments at the L5/S1 joint in lifting. *Clin Biomech.* 1996; 11, 101-110.  
 Pollack KM, Sorock GS, Slade MD, Cantley L, Sircar K, Taiwo O, et al. Association between body mass index and acute traumatic workplace injury in hourly manufacturing employees. *Am J Epidemiol.* 2007; 166(2):204-11.



## SUPPORTS AGAINST STATIC WORK IN BENDING POSITION – AN EMG-STUDY

HARTMANN B., BRADL I., GÜTSCHOW S.

BG der Bauwirtschaft, Arbeitsmedizinischer Dienst und AG Ergonomie, Hamburg, Germany

### Aims:

Back pain at physical work is a consequence of manual handling heavy loads and forced postures in bending / stooping positions. Construction workers are very often working at the ground. That's why it was checked what chances there are to decrease the work of muscles at lower back. Practical persons from construction work developed two different tools:

- A car for kneeling work with a chest support (Support A)
- A rack which is fixed at the workers body to support the muscular work in bending positions (Support B).

### Methods:

By an analysis with surface electromyography the solutions were judged by a test work if they take some of the load off.

In an experiment the work of laying tiled floor (ca. 15 m<sup>2</sup> tiles in the same time) three persons (age 18-19 years, height 179-186 cm, BMI 20,2, / 27,2 / 31,2) were investigated. Each person worked with solution A, B and without support. On each back side the surface-EMG of the Latissimus dorsi (Th10), Erector spinae (L2/3) und Multifidus (L4/L5) was measured.

### Results:

Both supports at all persons uprights the working positions in the lower back.

Laying tiles in comparison between working with and without back support the results of EMG showed:

- Experimenter 1 had lower EMG-activity with support A at all back muscles but especially at the Multifidus.
- Experimenter 2 has lower activities with both back supports. With support A only the right M. latissimus and M. multifidus had a little bit higher activities than work with out support.
- Experimenter 3 had accidental changes at the EMG of M. latissimus, but at all muscles of the lower back the activity was diminished lower than

### Conclusion:

The experimenters showed individual different results of muscular activity at all investigated muscles. EMG-Data of Multifidus showed at both sides the highest positive effects.

Predominantly there was an relief of the muscle strain with the supports and at all three persons. Support A is more useful as a common support in the prevention for people working at the floor in bending positions for a longer time. In the opposite Support B was more helpful when it is adapted to the body measures such as height and circumference of the chest and stomach. In practice an older worker with back pain felt subjective very helpful. In addition a functional relief comes from the raising of lumbar spine.

**Keywords:** Postures, Physical exposure, Construction, Back, low back

### References:

Bradl I, et al. (2001): Aktivierungsmuster der lokalen und globalen Rückenmuskulatur bei Übungen an medizinischen Trainingsgeräten. In: H.Ch. Scholle und N.P. Schumann (eds.) 4. Arbeitstagung Motodiagnostik - Mototherapie, Referate, Friedrich-Schiller-Universität Jena, 93-97.

Luttmann A et al. (2001): Untersuchung von Muskelbeanspruchung und -ermüdung mit Hilfe der Oberflächen-Elektromyographie. Teil 2: Anwendung in arbeitsphysiologischen Feldstudien. Zbl. Arbeitsmed. 51: 443-461.



## DETERMINANTS OF VARIATION IN GROSS PHYSICAL ACTIVITY DURING CUSTOMER CONTACT CENTRE WORK

HEIDEN M., TOOMINGAS A., MATHIASSEN S.E., FORSMAN M.

*Centre for Musculoskeletal Research, University of Gävle, Gävle, Sweden*

### Aims:

The aim of the study was to evaluate to what extent easily accessible company data and self-reported work-load could be used to estimate variation in gross physical activity during customer contact centre work.

### Methods:

As part of a comprehensive study of working conditions and health at customer contact centers (CCCs) in Sweden [1], whole-day recordings of seated versus standing/walking posture were made on 156 subjects from 16 CCCs. From the recordings, parameters describing posture variation were calculated. The parameters represented (i) level of exposure (e.g. percent time spent in seated position), (ii) frequency of change (e.g. switches between sitting and standing/walking), and (iii) similarity in exposure across time (e.g. correlations between the duration of consecutive episodes of sitting or standing/walking). In addition, company data (i.e., national/international CCC, public/private CCC, internal CCC within a mother company/external CCC as a separate enterprise, the complexity of the support given by the CCC, and the company policy of training in ergonomics) and subjects' ratings of their work-load were collected. The variation parameters were entered into stepwise linear regression models, with company data and individual ratings as independent variables. Significance of  $p < 0.05$  was used as a criterion for entry into the models, and  $p > 0.10$  was used for removal from the models.

### Results:

For the parameters representing exposure level, none of the potential determinants reached the inclusion level of significance. For the frequency parameters, company data in terms of internal/external CCC and the company policy of training in ergonomics were included in the models. However, these determinants explained only a small amount of the variance in the parameters (adjusted R<sup>2</sup> ranged from 4.0% to 5.1%). The strongest models were obtained for the similarity parameters, where company data (internal/external CCC) and self-reported data (number of calls per day, amount of time spent on different work tasks) explained 11-16% of the parameter variance (adjusted R<sup>2</sup> 8.8% – 13.8%).

### Conclusion:

Company data were included as significant determinants in the models estimating frequency of change and exposure similarity, albeit contributing only by a small amount of explained variance. Thus, it is likely that company data reflected different types of production systems and work organization that would influence the workers' variation in physical exposure. For some aspects of variation, self-reported data were also included in the estimation models, suggesting that easily accessible descriptors of the work are predictive of exposure variation.

**Keywords:** Postures, Physical exposure, Computer work, Exposure measurement methods

### Reference:

Norman K, Wigaeus-Tornqvist E, Toomingas A. Working conditions in a selected sample of call centre companies in Sweden. *Int J Occup Saf Ergon.* 2008;14(2):177-94.



## EVALUATION OF PUSHING AND PULLING AT THE WORKPLACE USING A WEB-BASED PUSH-PULL-CALCULATOR

HOOZEMANS M.J.M., VISSER B., VAN DIEËN J.H.

Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands.

### Aims:

Pushing and pulling of objects like carts and wheeled containers is a daily activity of a substantial number of workers and can be a risk factor for the development of musculoskeletal disorders. Recent epidemiological studies show that pushing and pulling are associated with a higher risk of shoulder pain and not necessarily of low back pain. Evaluation of pushing and pulling at the workplace often includes the assessment of exerted hand forces, which is often difficult to do at the workplace. Kuijjer et al. (1) presented a new approach for evaluating not only the exerted hand forces, but also the low back and shoulder load during pushing and pulling, without measuring the exerted hand forces. The objective of the present project was to develop a web-based application that applies this approach in a feasible manner.

### Methods:

The web-based PushPullCalculator can be used if wheeled containers are pushed or pulled on a level and smooth floor. Application of the PushPullCalculator requires the following information: gender, pushing or pulling, shoulder angle and elbow angle, handle height, use of one or two hands, weight of the cart (including load), distance and frequency of pushing or pulling.

### Results:

Using the required information the PushPullCalculator calculates the exerted hand forces (initial and sustained) and the load at the low back and shoulder (1,2). Existing guidelines are transformed into a traffic light model to evaluate the working situation. Separate guidelines are used for exerted hand forces, low back load and shoulder load. Boundaries in the traffic light model are defined such that the working situation is evaluated as green when 90% of the working population can safely perform the task. When only 50% of the working population can safely perform the task it is evaluated as red.

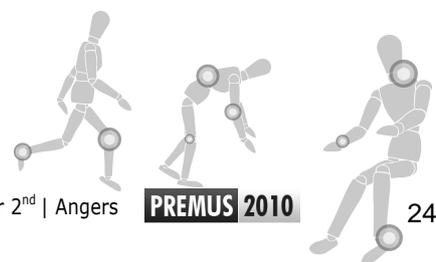
### Conclusion:

The PushPullCalculator is based on results of scientific studies with respect to pushing and pulling. This evidence-based application enables practitioners to estimate the exerted hand forces and the load of the low back and shoulders for pushing and pulling wheeled containers at the workplace. Moreover, these outcomes are compared with existing guidelines regarding maximum acceptable push or pull forces, compression forces on the low back and moments at the shoulders. The PushPullCalculator can be found at: <http://duwtrekcalculator.expertisecentrum-expres.nl/en/home>

**Keywords:** Biomechanics, postures, physical exposure, other

### References:

Hoozemans MJM, Kuijjer PPFM, Kingma I, van Dieën JH, de Vries WHK, van der Woude LHV, Veeger HEJ, van der Beek AJ, Frings-Dresen MHW. Mechanical loading of the low back and shoulders during pushing and pulling activities. *Ergonomics*. 2004;47(1):1-18.,  
Kuijjer PPFM, Hoozemans MJM, Frings-Dresen MHW. A different approach for the ergonomic evaluation of pushing and pulling in practice. *International Journal of Industrial Ergonomics*. 2007;37:855-62.



## THE EFFECTS OF THE UPPER LIMBS' PULLING AND PUSHING WORK IN STANDING POSTURE WITHIN THE MAXIMUM WORK AREA ON PLANTAR PRESSURE DISTRIBUTION

KANG J.W., KOO J.W.

*Dept. of Occupational and Environmental Medicine, Catholic Industrial Medical Center, The Catholic University of Korea, Seoul, Korea*

### Aims:

The present study aims to examine the plantar pressure distribution on the two lower limbs during the works of pulling and pushing objects of different weight (5 kg, 10 kg, 15 kg) at the maximum work area using the two arms in standing posture while manual materials handling (MMH) work.

### Methods:

We conducted an experiment with 10 male and 10 female healthy adults in their 20s. While the participants were pulling objects of different weights at the maximum right work area and pushing them at the maximum left work area in standing posture, we measured plantar pressure three times for each weight and obtained the mean value. In order to compare, (1) the peak plantar pressure for each work (pull, push) and five areas of the left and right feet; (2) the peak plantar pressure for each weight and the five areas of the left and right feet; and (3) the difference in the mean peak plantar pressure for the five areas of the left and right feet between men and women and between the left and right feet, we conducted two - way ANOVA, and used correlation analysis to examine the relation between weight, left foot, right foot, work type (pull - push) and MFPP (medial forefoot peak pressure), LFPP (lateral forefoot peak pressure), mFPP (medial foot peak pressure), MRPP (medial rearfoot peak pressure) and LRPP (lateral rearfoot peak pressure).

### Results:

The plantar pressure distribution of the two feet in standing posture was similar between men and women. In both feet, MFPP, LFPP, mFPP, MRPP and LRPP were significantly higher when working with 15 kg heavy objects than working with 5 kg or 10 kg heavy ones. Particularly in all the areas except MFPP, the peak plantar pressure was significantly higher in the left foot than in the right foot. In both feet, MFPP, LFPP, mFPP, MRPP and LRPP were significantly higher in pushing work than in pulling work ( $p < 0.05$ ). In both feet, MFPP, LFPP, mFPP, MRPP and LRPP were significantly higher in pushing work than in pulling work.

### Conclusion:

Our study that measured the change of the plantar pressure distribution initiated from the ground plantar side during the pulling and pushing work in a standing posture could be the basis of studies on the movement strategies and manual material handlings performed in a standing posture in future. Further biomechanical study is necessary on various types of pushing and pulling works in standing posture observed in actual workplaces.

**Keywords:** Biomechanics, Postures, Physical exposure

### References:

- Chaffin DB, Andersson GB, Martin BJ. Occupational Biomechanics. 3rd ed. John Wiley & Sons, 1999.  
Jorrit PJ, Marco JM, Hoozenmans MI, Allard J, Vander B, Monique HW. Evaluation of ergonomic adjustments of catering carts to reduce external pushing forces, Applied Ergonomics, 2002; 33(1): 117-127.  
Orlin MN, McPoil TG. Plantar pressure assessment. Phys Ther. 2000; 80(4):399-409.



## ASSESSMENT BY EXPERIMENTED TRAINERS OF A TOOL DESIGNED TO CHARACTERIZE MANUAL MATERIAL HANDLING SITUATIONS

LORTIE M., GONELLA M., ST-VINCENT M., DENIS D.

*Université du Québec à Montréal and Institut de Recherche en Santé et Sécurité du Travail, Canada*

### Aims:

To assess how a tool designed to characterize manual material handling situations would be received by potential users (ergonomists used to conduct training sessions) and to identify what could be improved. This tool has been developed form part of a larger project that consisted to develop a training program using a competency-based approach. This tool covers six areas : Variability of the handling situations (8 items), equipments used, main difficulties encountered (8 items), technical and socio organisational framework ( 6 and 10 items), OHS organisation (5 items).

### Methods:

The tool was tested by 13 ergonomics consultants used to provide training sessions in manual material handling. They were asked to fill three grids and to complete each time a short questionnaire (easiness to complete, clarity of questions, duration, coverage). It was completed with an interview (individual or in pair; topics: pertinence, usability, who could fill it, etc.).

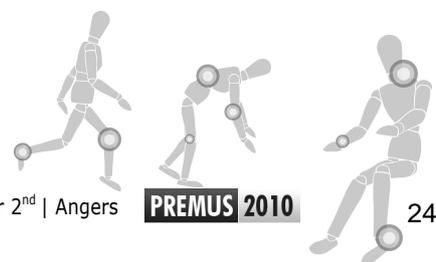
### Results:

The participants took between 30 and 45 minutes to complete a grid. They reported little difficulties to fulfill it. The tool was assessed as enough extensive; the fact to provide a way to organise and synthesise the data was appreciated. The points or concepts to be clarified and the suggestions or adding proposed will be presented as well as a general picture of the grids filled. Most participants saw the tool as a way to improve the dialog and the exchange with the enterprises. They asked to develop a version that could be used by the OHS committees or the management. They expressed the wish to get a tool which would have some kind of «official stamp».

### Conclusion:

The need to implicate experimented professionals in the process of the development of guidelines or tools is now well established. How they contributed to validate and improve the initial tool will be discussed. Their insistence to go further than our original intention was unexpected. Their need to get a tool that could improve and structure the quality of the exchanges with the enterprises was systematically discussed. Few tools met actually this need.

**Keywords:** Early prevention, intervention methods, other



## PHYSICAL ACTIVITY AND CARDIOVASCULAR REGULATION DURING CLINICAL WORK IN FEMALE STUDENTS WITH AND WITHOUT MUSKULOSKELETAL PAIN. METHOD STUDY.

FANI A., TZEMPARILIDIS N., UTTERSTRÖM K., HALLMAN D., WANMAN A., ERIKSSON P.O., LYSKOV E.

University of Gefle, Sweden

### Aims:

We have previously reported a high prevalence of head-neck-shoulder-back pain in dental students, higher in clinical than in preclinical semesters, especially in female students. The present study aimed to objectively assess patterns of physical activity in female students with pain and painfree controls, as well as interrelations with cardiovascular regulations, that might be involved in pathogenesis.

### Methods:

From a population of 93 female and 69 male dental students participating in a questionnaire study, a subgroup of females was selected from clinical semesters, eight with longstanding pain in the jaw-face, head-neck-shoulder and back regions (cases) and eight pain free (controls). Of these, six cases and three controls were examined using an ambulatory data collecting device (IDEEA®) for quantifying physical activity (body posture and motion, distance traveled), energy expenditure, and ECG and heart rate, in 24h continuous recordings. Stress level and pain during clinical work were rated. Each subject was recorded three times with one week interval. Blood pressure and heart rate were registered before and after recordings.

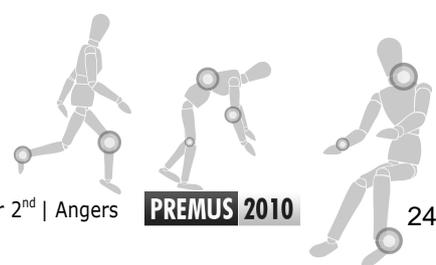
### Results:

Both cases and controls reported higher stress level during clinical work, but only cases reported higher pain intensity. Students with pain typically spent more time in sitting position and less in standing, in comparison with controls. Total distance and mean speed of motion during 24 hours observations were lower in the case group. The mean heart rate was higher during clinical work than in the evening in both cases and controls. Intra-individual variability for the majority of outcomes describing physical activity was relatively low in repeated recordings.

### Conclusion:

Increase in stress level and cardiovascular reactivity during clinical work both in cases and controls suggests complex interactions between physical and mental strains and autonomic nervous system response. Low variability between repeated recordings reflects reliability in objective monitoring of physical activity. The results suggest that ambulatory data collection may be useful when identifying mechanisms behind musculoskeletal pain, and justify further studies

**Keywords:** Postures, physical exposure, health care workers, pain, chronic pain



## THE EFFECTS OF POSTURE AND FATIGUE ON LUMBAR MOTION AND ERECTOR SPINAE MUSCLE ACTIVATION DURING HIGH FREQUENCY LIFTING AND LOWERING.

MAWSTON G.A., BOOCOCK M.G., MCNAIR P.J.

*Health and Rehabilitation Research Institute, Department of Physiotherapy, AUT University, Auckland, New Zealand.*

### Aims:

Postural advice has been considered an important component of low back injury prevention in high risk vocations involving high frequency lifting. However, there is a dearth of information about the influence of a self-selected lifting posture and fatigue on known risk factors (lumbar flexion and angular velocity) for low back injury. Therefore, the aim of this study was to examine the effects of initial self-selected lifting posture (squat, stoop or mixed) and fatigue on lumbar spine kinematics (lumbar flexion and angular velocity) and paraspinal muscle activation during a high frequency lifting and lowering task.

### Methods:

Thirty-one male subjects between the ages of 18 and 35 years were required to lift and lower a 13 kg box using a self-selected posture 20 times per minute until fatigued. Initial lifting posture (squat, mixed or stoop) was visually identified at the beginning and end of the lifting and lowering task. Lumbar spine motion in the sagittal plane was calculated from pairs of markers attached to the upper lumbar spine and sacrum and expressed as percentage of lumbar motion recorded during toe touching in standing. Surface electromyography from upper and lower erector spinae muscle groups on the right side of the trunk were also collected simultaneously throughout the lifting and lowering task.

### Results:

Subjects maintained their original lifting posture throughout the task. Stoop lifters flexed their spine to end range of motion and produced significantly greater lumbar angular velocity during both lifting and lowering than those using a squat technique ( $P<0.05$ ). During lifting and lowering, squat lifters maintained or increased upper and lower erector spinae muscle activation, whereas stoop lifters significantly decreased their levels of lower erector spinae muscle activation at the end of the lowering phase when the spine was in maximal flexion ( $P<0.05$ ). When fatigued the stoop lifters significantly reduced the extent and velocity of lumbar extension ( $P<0.05$ ), whereas squat lifters maintained similar lumbar kinematics to the non-fatigued state.

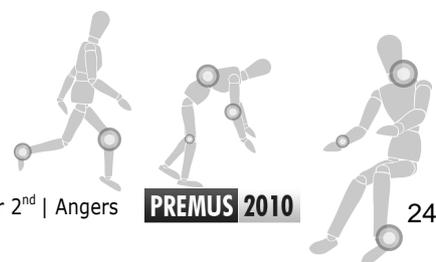
### Conclusion:

The findings suggest that individuals who adopt a stoop lifting technique place their lumbar spine at end range flexion are more likely to place greater stress on the passive structures of the spine. Furthermore, the ability to rapidly extend the spine may be compromised in stoop lifters when fatigued indicating that lifters who adopt a stoop lift may be at greater risk of spinal injury with fatigue.

**Keywords:** Biomechanics, postures, physical exposure, back, low back

### Reference:

Adams, M. A., Dolan, P., Marx, C., & Hutton, W. C. (1986). An electronic inclinometer technique for measuring lumbar curvature. *Clinical Biomechanics*, 1(3), 130-134.



## A TOOL FOR THE ASSESSMENT OF HANDLING OF LOADS - THE HUT-CALCULATOR

MUEHLEMEYER C., NEUMANN B., SCHAEFER A., LANG K.H.

*Institute of Occupational Health, Safety and Ergonomics (ASER), Wuppertal, Germany*

### Aims:

The aim of this project was to develop a computer-aided tool for the assessment of work-processes with manual “lifting and carrying” of loads (HuT = German abbreviation HuT [Heben und Tragen]) as a guide to implement the manual handling of loads regulations. This calculator should include the assessment of manual handling of loads with the “key indicator methods” for “lifting/carrying” and for “pulling and pushing” [1] the “NIOSH Method” [2] and the technical standard “EN 1005 part 2” [3].

### Methods:

All assessment parameters of the different methods mentioned above were implemented in the tool (weight of the load, distance to the grip, height of the load before lifting, lifting frequency and so on). A structured surface of the tool was designed, giving typical examples of body postures or work situations.

### Results:

During a work place analysis, the assessment parameters have to be determined. After entering the observed parameters in the data mask of the HuT-calculator, the user receives an evaluation of the load situation automatically. In addition, a report with all results is generated. Recommendations about the need of measures according to prevent musculoskeletal symptoms or disorders are included as well. The user can save the results and can also change the parameters. A report provides an overview of all input and output parameters. The report can be printed and also converted into different file formats.

### Conclusion:

The advantage by using this tool is the possibility to compare the same work situation with different methods in one step. Due to the different underlying methods, different results will occur. This tool could be used during assessment of existing work places or in the area of Industrial Engineering during the planning phase of work places. A careful planning of new workplaces and the calculation of the physical workload before the implementation might reduce the risk of work related musculoskeletal symptoms or disorders.

The tool is available free of charge at [www.institut-aser.de/tools.htm](http://www.institut-aser.de/tools.htm) in German and English language.

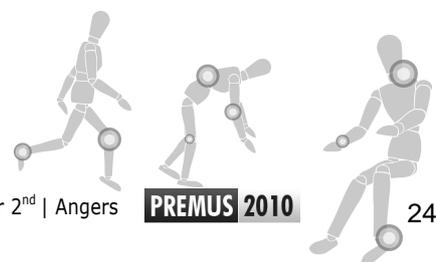
**Keywords:** Postures, physical exposure, exposure measurement methods, early prevention

### References:

[1] The Key Indicator Methods (KIM-Tools). <http://www.handlingloads.eu/en/site/18/19>,

[2] Waters TR, Putz-Anderson V, Garg A, Fine LJ (1993): Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics* 36(7):749-776.

[3] DIN EN 1005-2 (2003): Safety of machinery - Human physical performance - Part 2: Manual handling of machinery and component parts of machinery. Deutsche Fassung: DIN EN 1005-2:2003, Beuth Verlag, Berlin.



## PHYSICAL WORKLOAD, LOW BACK PAIN AND NECK-SHOULDER PAIN - A SWEDISH TWIN STUDY

NYMAN T., MULDER M., ILIADOU A., SVARTENGREN M., WIKTORIN C.

*Department of Public Health Sciences, Division of Occupational and Environmental Medicine, Karolinska Institutet, Stockholm, Sweden*

### Aims:

To investigate if high physical workload is associated with low back pain (LBP) and/or neck-shoulder pain (NSP) when taking into account the influence of genetic and shared environmental factors. Further, to explore if the association with high physical workload differs between Solely LBP, Solely NSP, and Concurrent LBP and NSP.

### Methods:

Data on 15054 monozygotic and dizygotic twins, born 1959-1985, was obtained from a cross-sectional study, performed in 2005-2006 and administered by the Swedish Twin Registry. Odds ratios (OR) were calculated in the cohort analyses and co-twin control was used to assess the association between high physical workload and LBP and NSP controlling for genetic and shared environmental factors. Exposure to high physical workload was based on a classification system which took into consideration eight different physical strain dimensions, among others heavy lifting, repetitive work, and awkward work postures.

### Results:

In the co-twin control analyses, the odds ratios between High physical workload and the group with any one symptom (LBP and/or NSP), were OR 1.31 (95%CI 1.00-1.72) for dizygotic twins and 1.44 (95%CI 1.06-1.96) for monozygotic twins indicating that the association between High physical workload and LBP and NSP was not confounded by genetic and shared environmental factors. Concurrent LBP and NSP was the only group that showed a stepwise decrease of the point estimates between the cohort analysis, OR 1.80 (95%CI 1.62-2.01), and the co-twin control analyses, OR 1.67 (95%CI 0.97-2.86) for dizygotic twins, and OR 1.29 (95%CI 0.64-2.58) for monozygotic twins indicating confounding of genetic and shared environmental factors.

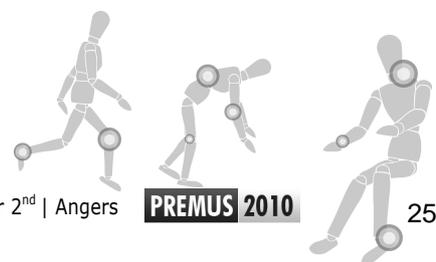
### Conclusion:

High physical workload was associated with LBP and/or NSP even after adjusting for genetic or shared environmental factors. The associations did not differ between the groups Solely LBP, Solely NSP, and Concurrent LBP and NSP when adjusting for genetic and shared environmental factors. However, for Concurrent LBP and NSP, genetic and shared environmental factors might explain part of the association with high physical workload. The results emphasises the continuous need for preventive workplace interventions in occupations with high physical workload. Further, the results also support earlier findings that Concurrent LBP and NSP seems to differ in some respects from Solely LBP or Solely NSP (Nyman, 2006; Strine 2007).

**Keywords:** Postures, Physical exposure, Personal risk factors for MSD, Epidemiology

### References:

Nyman T., Grooten W.J.A., Wiktorin C., Norrman L., and Liwing J. Sickness absence and concurrent low back- and neck-shoulder pain: Results from the MUSIC-Norrköping study. *Eur Spine J.* 2007;16(5):631-8.  
Strine, T.W. and Hootman J.M., US national prevalence and correlates of low back and neck pain among adults. *Arthritis Rheum.* 2007;57(4): 656-65.



## ERGONOMICS INTERVENTION USING MOVEMENT ANALYSIS SYSTEM AND 3D MODELING TECHNIQUES: A CASE FROM INDUSTRIALLY DEVELOPING COUNTRY (IDC).

TORRES Y., RODRIGUEZ Y., VIÑA S.

Department of Industrial Engineering, Higher Technical University "José Antonio Echeverría", La Habana, Cuba.

### Aims:

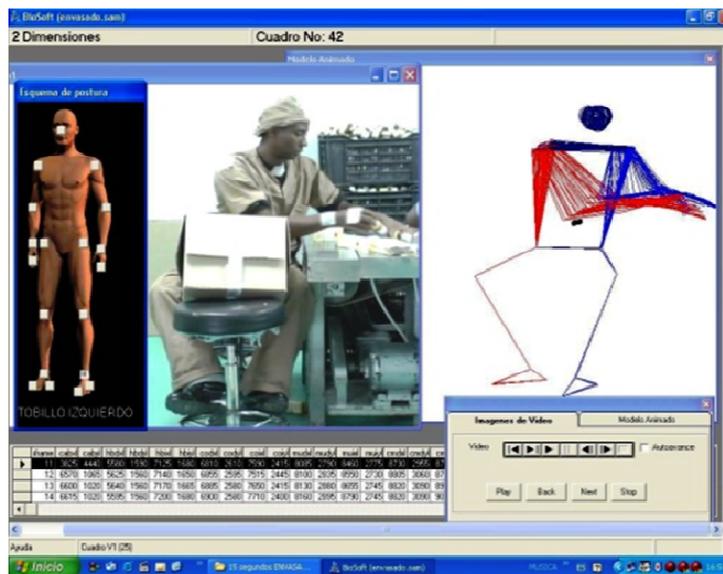
To illustrate the use of some advanced techniques within an ergonomic intervention in the context of an IDC.

### Methods:

The study was carried out in a pharmaceutical production facility. Three different workplaces were selected from one packing line with the purpose of evaluate extreme working postures and movements. Analysis of work method and postures were conducted in order to find out possible field of improvements. Videos of tasks were recorded from different angles for facilitating evaluation with Movement Analysis System (developed by Cuban programmer to be used in sport science) and with RULA ergonomic tool (Corlett and McAtamney 1993). After the evaluation workplaces were redesigned taking into consideration anthropometrics of Cubans and the ergonomics viewpoint. Then new designs were sketched in 3D models with the objective to be re-evaluated and presented to workers and staff member to obtain feedback.

### Results:

The evaluation of working postures revealed unacceptable work condition. RULA score were 6 and 7 for most of extreme postures, meaning a high degree of risk. Movement Analysis System showed a significant deviation from neutral position for neck and trunk angles as well as deviation in central gravity point, with the consequent lack of stability. The redesign contributed to decrease RULA scores. Postures at most significant risk level decrease the score to 1-2, the lowest in the RULA score system. Improvement in angles deviation and central gravity point were possible too. The use of pictures and 3D videos of new designs made possible a greater understanding and feedback with workers.



### Conclusion:

The use of advanced techniques within the ergonomic intervention could lead in more effective evaluation and re-design process. It also ensures participation of worker and ways of support it; furthermore the study shows that it is possible in some cases conduct high standard ergonomics interventions within an IDC.

**Keywords:** Postures, Physical exposure, Intervention methods, Upper limb

### Reference:

Corlett, E. N. and L. McAtamney (1993). "RULA: a survey method for the investigation of work-related upper limb disorders." Applied Ergonomics 24(2): 91-99.



## PRICE VERSUS PRECISION: COST EFFICIENCY IN TRUNK POSTURE OBSERVATION

TRASK C.M.<sup>1</sup>, MATHIASSEN S.E.<sup>2</sup>, TESCHKE K.<sup>3</sup>, KOEHOORN

<sup>1</sup> Centre for Musculoskeletal Research, Gävle, Sweden - <sup>2</sup> Centre for Musculoskeletal Research, Gävle, Sweden - <sup>3</sup> University of British Columbia School of Population and Public Health, Vancouver, Canada - KOEHOORN

### Aims:

There is a long-acknowledged tradeoff between precision and cost of exposure assessment strategies (Winkel and Mathiassen, 1994), but a dearth of literature quantifying this tradeoff. This study compares different sampling strategies for trunk posture observation with respect to monetary costs and statistical efficiency.

### Methods:

Experts observed 126 workers in heavy industry during full work shifts, with repeated measures on 76% of workers. The observed percentage of time spent with trunk flexed more than 60 degrees was recorded and summarized for each work day using the Back-EST sampling method (Village et al 2009). A model of costs associated with the data sampling strategy was developed using previously published data (Trask et al 2007), accounting for the costs of recruiting companies and workers, and of observing full work shifts. Statistical performance was described as standard error of the mean (SEM). Post hoc, a selection of sampling strategies were simulated to demonstrate the empirical tradeoff between cost and efficiency for different sampling strategies.

### Results:

Figure 1 shows the family of curves resulting when 1 to 10 workers are measured 1 to 4 times within a single company. The SEM declines steeply for the first few additional subjects, while further subjects increase costs considerably with no substantial improvements in precision. Adding repeated measures generally increased costs with smaller gains in precision.

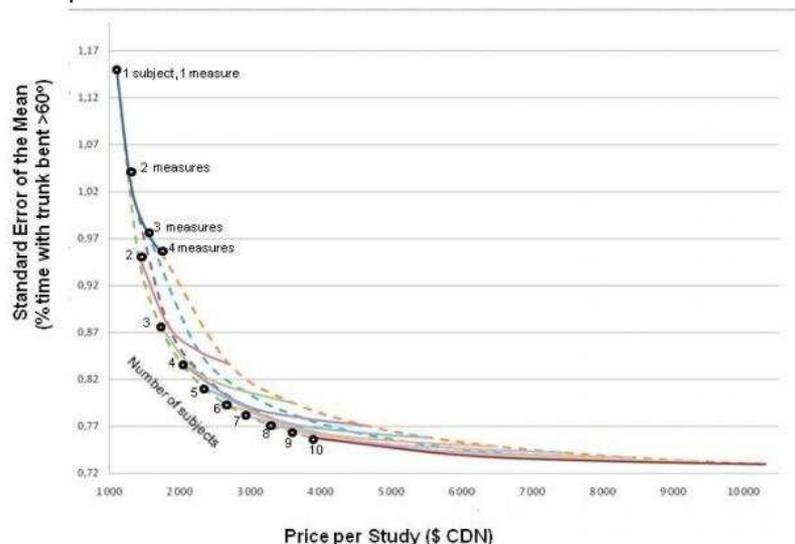


Figure: Price versus standard error of the mean of observed posture measurements for different sampling schemes within a single company. Based on collected data, the subject recruitment cost was set at CDN\$ 94 and the cost of a measurement day set at CDN\$ 216.

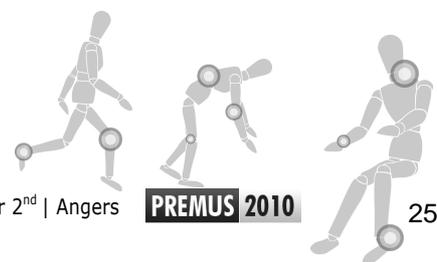
### Conclusion:

This study informs design of posture observation sampling campaigns; the 'mesh' of sampling strategies in the figure demonstrates the maximum precision level that can be achieved for a given cost, as well as the minimum cost for a given level of precision. This allows researchers to make informed decisions on the use of limited resources when designing ergonomic studies.

**Keywords:** Postures, physical exposure, exposure measurement methods, back, low back

### References:

Trask, C., Teschke, K., Village, J., Chow, Y., Johnson, P., Luong, N., and Koehoorn, M. Measuring low back injury risk factors in challenging work environments: an evaluation of cost and feasibility. *American Journal of Industrial Medicine*. 2007. 50 (9), 687-96.  
 Village, J., Trask, C., Luong, N., Chow, Y., Johnson, P., Koehoorn, M., and Teschke, K. Development and evaluation of an observational Back-Exposure Sampling Tool (Back-EST) for work-related back injury risk factors. *Applied Ergonomics*. 2009. 40, 538-44.  
 Winkel, J. and Mathiassen, S. E. Assessment of physical work load in epidemiologic studies: concepts, issues and operational considerations. *Ergonomics*. 1994. 37 (6), 979-88.



## MAXIMUM ISOMETRIC FORCES OF THE WHOLE-BODY IN NOT UPRIGHT POSTURES AND HAND-FINGER-FORCES FOR THE ASSEMBLY-SPECIFIC FORCE ATLAS

WAKULA J., SCHAUB K.H., BERG K., BRUDER R., GLITSCH U., ELLEGAST R.P.

Institut für Arbeitswissenschaft, Technische Universität Darmstadt (IAD), D-64287 Darmstadt, Germany and Institut für Arbeitsschutz der DGUV (BGIA), D-53757 Sankt Augustin, Germany

### Aims:

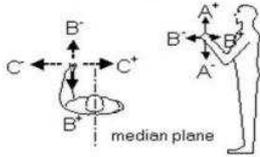
Measurement of maximum isometric forces of the whole-body system and hand-finger system related to typical postures in real working situations for the vehicle, utility vehicle, and air traffic industry; Modelling of the force assessment method for shop floor and planning analyses.

### Methods:

The subjective /direct method according to KROEMER (WAKULA et al., 2009; BERG et al., 2008) have been used to measure maximum isometric forces for both systems. 273 subjects (workers) from six industrial partners took part in the field study during a year.

### Results:

Results regarding maximum isometric forces of the arm-shoulder & whole-body system have been evaluated and analysed for 54 cases (nine postures while the persons sit, knee, or stand, each with six directions of force, fig.1). Additionally maximum forces of the left and right hand-finger-system for the sitting and standing position have been analysed for 38 cases. A force assessment method for shop floor and planning analyses was modelled in line with current scientific knowledge and the results of the own studies.

Force assessment method for shop floor and planning analyses									
$F_{max}$ whole body action forces [N]									
resultan F max for mens ( for women is multiplier 0,5 to use)									
The data from measurements have been rounded to 5 N									
P15 : 15.th force percentile for mens - planning data									
P 50: 50.th force percentile for mens - risk analysis data									
upright	P15	P50	bent	P15	P50	above shoulder	P15	P50	
	A <sup>+</sup> : 380 ↗ A <sup>-</sup> : 405 ↘ B <sup>+</sup> : 260 ↖ B <sup>-</sup> : 380 ↗ C <sup>+</sup> : 205 ↘ C <sup>-</sup> : 170 ↙	515 ↗ 530 ↘ 340 ↖ 505 ↗ 315 ↘ 280 ↙		A <sup>+</sup> : 320 ↗ A <sup>-</sup> : 305 ↘ B <sup>+</sup> : 315 ↖ B <sup>-</sup> : 440 ↗ C <sup>+</sup> : 225 ↘ C <sup>-</sup> : 140 ↙	485 ↗ 405 ↘ 420 ↖ 645 ↗ 335 ↘ 230 ↙		A <sup>+</sup> : 360 ↗ A <sup>-</sup> : 245 ↘ B <sup>+</sup> : 415 ↖ B <sup>-</sup> : 395 ↗ C <sup>+</sup> : 160 ↘ C <sup>-</sup> : 150 ↙	455 ↗ 520 ↘ 330 ↖ 525 ↗ 235 ↘ 235 ↙	
standing - upright	h = 1500 mm		standing bent	h = 1100 mm		above shoulder	h = 1700 mm		
	A <sup>+</sup> : 320 ↗ A <sup>-</sup> : 345 ↘ B <sup>+</sup> : 335 ↖ B <sup>-</sup> : 370 ↗ C <sup>+</sup> : 225 ↘ C <sup>-</sup> : 180 ↙	450 ↗ 455 ↘ 485 ↖ 530 ↗ 335 ↘ 265 ↙		A <sup>+</sup> : 275 ↗ A <sup>-</sup> : 290 ↘ B <sup>+</sup> : 335 ↖ B <sup>-</sup> : 340 ↗ C <sup>+</sup> : 220 ↘ C <sup>-</sup> : 160 ↙	410 ↗ 360 ↘ 555 ↖ 475 ↗ 310 ↘ 230 ↙		A <sup>+</sup> : 345 ↗ A <sup>-</sup> : 410 ↘ B <sup>+</sup> : 320 ↖ B <sup>-</sup> : 340 ↗ C <sup>+</sup> : 200 ↘ C <sup>-</sup> : 200 ↙	460 ↗ 520 ↘ 430 ↖ 445 ↗ 300 ↘ 295 ↙	
kneeling - upright	h = 800 mm		kneeling bent	h = 600 mm		above shoulder	h = 1100 mm		
	A <sup>+</sup> : 315 ↗ A <sup>-</sup> : 375 ↘ B <sup>+</sup> : 330 ↖ B <sup>-</sup> : 315 ↗ C <sup>+</sup> : 190 ↘ C <sup>-</sup> : 175 ↙	435 ↗ 465 ↘ 435 ↖ 410 ↗ 270 ↘ 260 ↙		A <sup>+</sup> : 295 ↗ A <sup>-</sup> : 300 ↘ B <sup>+</sup> : 380 ↖ B <sup>-</sup> : 325 ↗ C <sup>+</sup> : 205 ↘ C <sup>-</sup> : 155 ↙	425 ↗ 400 ↘ 485 ↖ 450 ↗ 300 ↘ 230 ↙		A <sup>+</sup> : 330 ↗ A <sup>-</sup> : 395 ↘ B <sup>+</sup> : 305 ↖ B <sup>-</sup> : 325 ↗ C <sup>+</sup> : 155 ↘ C <sup>-</sup> : 150 ↙	410 ↗ 475 ↘ 390 ↖ 390 ↗ 215 ↘ 220 ↙	
sitting - upright	h = 1000 mm		sitting bent	h = 800 mm		above shoulder	h = 1200 mm		

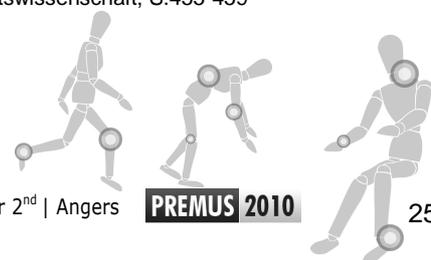
### Conclusion:

The force assessment method allows the user to derive maximum recommended action force values from maximum isometric action forces while taking into account specific task and operator related parameters. It is applicable for design engineers, production planners, safety engineers, physicians of occupational medicine, and ergonomists.

**Keywords:** Biomechanics, Postures, Physical exposure, Personal risk factors for MSD

### References:

Wakula, J., Berg, K., Schaub, Kh., Glitsch, U., Ellegast, R., Bruder, R. BGIA-Report 2009, Deutsche Gesetzliche Unfallversicherung (DGUV) (Hrsg.) Der montagespezifische Kraftatlas  
 Berg, K. Wakula, J. Schaub, Kh. 2008, Isometrische Maximalkräfte des Hand-Fingersystems für einen montagespezifischen Kraftatlas. Dokumentation des 54. Kongresses der Gesellschaft für Arbeitswissenschaft, 637-640  
 Schaub, Kh., Berg, K., Wakula, J., Glitsch, U., Ellegast, R., Bruder, R. (2009) Entwicklung eines Kraftbewertungsverfahrens im Rahmen des montagespezifischen Kraftatlas. Bericht zum 55. Kongress der Gesellschaft für Arbeitswissenschaft, S.455-459



## INFLUENCE OF HANDLING ITEMS ON THE MAIN DETERMINANTS OF RISK FACTORS FOR MSD DURING CASHING ACTIVITY IN MASS MARKET RETAILING

ALVES H.<sup>1</sup>, ZANA J.P.<sup>2</sup>, MUZEAU B.<sup>1</sup>, PORTERO P.<sup>3</sup>

<sup>1</sup> INRS, Paris, France - <sup>2</sup> Ergorythme, Choisy-le-Roi, France - <sup>3</sup> EAC 7054 CNRS Paris-Est-Créteil University, Paris, France

### Aims:

Observe and evaluate motor strategies (raised or pushed / pulled) during a day activity. The hypothesis is that cashiers change their strategy with the probable emergence of tiredness.

### Methods:

Fifty confirmed cashiers and volunteers spread over three brands of hypermarkets / supermarkets and hard discount have participated in this study.

Three questionnaires have been used: the simplified Nordic questionnaire, the discomfort questionnaire and Baecke questionnaire.

The cashiers activity was recorded during 5 hours in video then the 1st and the last half hour were analyzed to observe and evaluate the motor strategies in terms of lift and push / pull.

### Results:

During cashing activity, the results show that the hand nearest the carpet is used for catching and putting down over 90% of handled items.

Between the beginning and end of activity (5 hours), operators reduce significantly (5 to 7%) gestures of carrying giving the advantage to push-pull gestures, whatever the considered member (entry and exit of carpet).

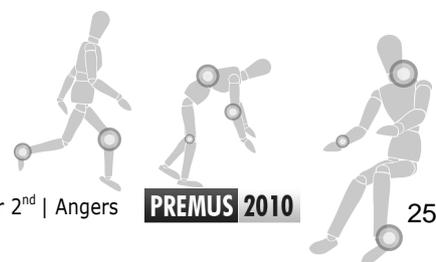
The simplified Nordic questionnaire shows that there is a clear predominance of pain in the lumbar region and cervico-scapular. These pains are mostly daily or several times per week. The discomfort questionnaire results clearly reinforce those in the the simplified Nordic questionnaire. The Baecke questionnaire shows that the studied population does not practice any sport.

### Conclusion:

The modification of gesture may correspond to a motor strategy of adaptation allowing subjects to reduce constraints on the musculo-tendon according to the setting up of fatigue process. This can be considered a "natural response" to the hard work during several hours. This phenomenon may be associated or not to the ability of muscle relaxation during phases of non-engagement of the articles. This inability to relaxation has been already mentioned as a risk factor promoting at long-term the overload of the musculoskeletal system.

Moreover, the workspace design, the orientation of carpets release (exit), the presence of a double scanner and the obstruction of the carpet release (exit) influence the activity of operators. This study confirms the results of a preliminary study in experimental condition. The analysis in real situation enables a more precise determination of physiological constraints taking into account the organizational and environmental determinants. A better knowledge of work situations enables to consider an update of preventive approaches needed to reduce risks faced by supermarkets staff.

**Keywords:** Postures, physical exposure, specific sectors, intervention studies



## PSYCHOSOCIAL FACTORS

### RISK FACTORS FOR ONSET OF PERSISTENT BACK PAIN AMONG JAPANESE WORKERS; FINDINGS FROM A PROSPECTIVE STUDY : THE JAPAN EPIDEMIOLOGICAL RESEARCH OF OCCUPATION-RELATED BACK PAIN (JOB) STUDY

MATSUDAIRA K., ARISAKA M., SAWADA T., ISOMURA T.

*Clinical Research Center for Occupational Musculoskeletal Disorders, Japan*

#### Aims:

There is strong evidence that psychosocial variables are strongly linked to the transition to chronic back pain disability. However, this evidence has not been well investigated in Japan. It is important to assess what factors affect low back disability (LBD) in Japanese workers because some of these factors, especially psychosocial factors, which are mainly subjective, are subject to cultural and environmental differences. We conducted a prospective study.

#### Methods:

5,310 workers from multiple industries completed a questionnaire at baseline, and we followed up a prospective cohort of 3,811 workers for one year. The data collected at baseline included LBP severity and possible individual, ergonomic or psychosocial risk factors. In our analysis, we assessed the relationship between a onset of LBD chronicity (more than three months of persistent LBP over one year), and potential risk factors by using data from 1,675 workers who had the mild LBP (not interfering with work) in the year prior to baseline. Odds ratios (ORs) were employed and computed from logistic regression. LBD was defined as LBP interfering with work and/or leading to sick leave.

#### Results:

2.6% of the workers developed onset of persistent back pain (LBD chronicity). Statistically significant associations in the univariate analyses were found for “manual handling of  $\geq 20$  kg and/or caregiver” “frequent bending, twisting, and pushing”, “family history of LBP with disability” “tendency of somatization” “low job satisfaction”, and “low social supports by supervisors”. The result of multivariate analysis adjusting for the other variables considered potential confounders, as well as age and gender are presented in Table 1

**Table 1** Multivariate-adjusted odds ratios for the onset of persistent back pain: LBP with work disability for more than 3 months (n=1675, who had the mild LBP in the year prior to baseline)

Risk factors (predictors)	Adjusted odds ratio *	95% CI
Manual handling of $\geq 20$ kg and/or caregiver (vs. no manual handling; mainly desk work)	3.61	1.77-7.36
Family history of LBP with disability (vs. no)	2.04	1.06-3.93
High tendency of somatisation (vs. low-normal)	2.36	1.22-4.55
Low job satisfaction (vs. normal-high)	2.13	1.09-4.14

\* Adjusted for age and gender.

#### Conclusion:

Our results indicated that psychosocial factors are one of the most important factors in the onset of LBD (persistent back pain) in Japan. Both ergonomic and psychosocial management interventions may be necessary in preventative strategies for LBD.

**Keywords:** Psychosocial factors, Back, low back, Pain, chronic pain

#### References:

- inton SJ: Psychological Risk factors for neck and back pain. Neck and Back Pain: The Scientific Evidence of Causes, Diagnosis and Treatment. In Nachemson AJ, Jonsson E, editors. Philadelphia. P.A. Lippincot Williams & Wilkins;2000.0.57-78
- Manek NJ, MacGregor AJ. Epidemiology of back disorders: prevalence, risk factors and prognosis. *Curr Opin Rheumatol* 2005; 17:134-40
- Hoogendoorn WE, van Poppel MN, Bongers PM, Koes BW, Bouter LM. Systematic review of psychosocial factors at work and private life as risk factors for back pain. *Spine* . 2000 Aug 15;25(16):2114-25



## WORK EXPERIENCES IN THE BEGINNING OF THE PROFESSIONAL CAREER – ANALYSES AMONG NURSES AND PHYSICIANS USING THE EFFORT-REWARD MODEL.

ENBERG B., ÖHMAN A., SUNDELIN G.

Umeå University, Umeå, Sweden

### Aims:

The aim of the study was to scrutinise how nurses and physicians, employed by the county councils in Sweden, assess their work environment in terms of effort and reward at the start of their career. The aim was also to estimate associations between work satisfaction and the potential outcomes from the effort-reward imbalance questionnaire.

### Methods:

The study group consists of 198 nurses and 242 physicians who graduated in 1999 and is a sub-sample drawn from a national cross-sectional survey. Data was collected in the fourth year after graduation among registered physicians and in the third year after graduation among the nurses. The effort-reward model, used in this study, is developed by Johannes Siegrist and focuses on reciprocity of exchange in occupational life (1). The effort-reward imbalance questionnaire, containing questions on effort at work, reward at work, together with a question on work satisfaction, was used to evaluate psychosocial factors at work.

### Results:

The results reveal that nurses scored higher on effort, lower on reward and experienced higher effort-reward imbalance compared with physicians. Women scored higher on work-related overcommitment compared with men. Among the physicians, logistic regression analysis revealed a statistically significant association between work-related overcommitment and sex, effort, reward and effort-reward imbalance. Among the nurses, logistic regression analysis revealed a statistically significant association between work-related overcommitment and effort and between work-related overcommitment and effort-reward imbalance. Dissatisfaction with work was significantly higher among those who scored worst on the effort-reward imbalance subscales (effort, reward and work-related overcommitment) and also among those with the highest effort-reward ratios compared with the other respondents.

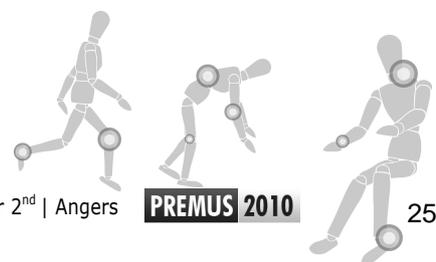
### Conclusion:

In conclusion, to prevent future work related health problems and work dissatisfaction among nurses and physicians in the beginning of their professional careers, signs of poor psychosocial working conditions have to be taken seriously. In future work-related stress research among healthcare personnel, gender-specific aspects of working conditions must be further highlighted in order to develop more gender-sensitive analyses.

**Keywords:** Health care workers, Psychosocial factors, Gender differences.

### Reference:

Siegrist J. Adverse health effects of high-effort/low-reward conditions. *J Occup Health Psychol.* 1996; 1:27-41



## RISK FACTORS FOR MUSCULOSKELETAL SYMPTOMS AMONG CALL CENTER RESERVATION AND HEALTH MANAGED CARE OPERATORS IN SÃO PAULO, BRAZIL.

ROCHA L.E., GLINA D.M.R., GIMENES M.J.F., FISCHER F.M.

*School of Medicine University of São Paulo- LIM 40, Brazil*

### **Aims:**

Identify risk factors for musculoskeletal symptoms among call center reservation and health managed care operators in São Paulo, Brazil.

### **Methods:**

A cross sectional study was carried out with 476 operators in activity who voluntarily answered a self-applied questionnaire involving: individual characteristics, work-related risk factors and the presence of musculoskeletal symptoms during the past 12 months. The final model of the logistic regression included only variables that remained associated in an independent form ( $p < 0.05$ ) to the presence of symptoms in the region studied.

### **Results:**

Women represented 75% of the call center operators, 46,8% of them were in the age bracket of 18 to 24 years. Daily working time was 6-hour with 20 to 30 minutes break. Workers remained seated 95% of the time, typing and answering telephone calls. The prevalence of symptoms according to location was: 52% on wrists/hands (CI 95%,47-56); 49% on lumbar column (CI 95%,44-53) and 43% on neck (CI 95%,38-47). Risk factors associated with wrist/hand symptoms were: inadequate table (OR 3.12 95%CI,1.71-5.71); being female (OR 2.60 95%CI,1.56-4.32); work organization (OR 1.55 95%CI,1.24-1.94); short rest breaks (OR 2.36 95%CI,1.36-4.09); insufficient training (OR 2.00 95%CI,1.22-3.29); job dissatisfaction (OR 1.87 95%CI,1.19-2.92); college level (OR 2.33 95%CI, 1.22-4.46); moderate to heavy domestic activities (OR 1.85 95%CI,1.15-2.97); weekly working hours of 36 hours (OR 2.22 95%CI,1.09-4.52); being more than 35 years old (OR 0.52 95%CI,0.28-0.94) and being college student (OR 1.80 95%CI,1.00-3.21). Risk factors associated with neck symptoms were: being female (OR 2.48 95%CI,1.50-4.08); job dissatisfaction (OR 2.16 95%CI,1.42-3.28); poor condition of workstation (OR 1.41 95%CI,1.14-1.74) and insufficient number of workers (OR 1.67 95%CI,1.08-2.60). Risk factors associated with lumbar spine symptoms were: bad chair (OR 2.83 95%CI,1.81-4.43); work organization (OR 1.39 95%CI,1.12-1.71); lack of recognition and autonomy (OR 1.35 95%CI,1.10-1.66); moderate to heavy domestic activities (OR 1.68 95%CI,1.10-2.56) and being female (OR 1.63 95%CI,1.01-2.64).

### **Conclusion:**

Prevention of musculoskeletal symptoms requires an integrated approach including improved workstation design, work organization and psychosocial factors.

**Keywords:** Computer work, Work organization, Epidemiology



## PSYCHOSOCIAL WORK FACTORS AND SHOULDER PAIN IN HOTEL ROOM CLEANERS

BURGEL B.J., WHITE M., GILLEN M., KRAUSE N.

*University of California San Francisco School of Nursing, USA*

### **Aims:**

To measure the prevalence of severe/very severe shoulder pain in hotel room cleaners; and to measure the associations between psychosocial work factors [job strain, iso-strain, and effort-reward imbalance (ERI)] and shoulder pain, controlling for socio-demographic, behavioral, anthropometric, biomechanical, and hotel factors.

### **Methods:**

This study was a secondary data analysis of cross-sectional data. In 2002, 941 of 1,276 (74%) room cleaners from 5 unionized Las Vegas hotels completed a survey of workplace factors and musculoskeletal symptoms. For this study, 493/941 (52%) with complete data for 21 variables were included in logistic analyses. Variables captured the socio-demographic, biomechanical individual factors and hotel factors known to be associated with adverse musculoskeletal outcomes.

### **Results:**

Fifty-six percent (n=274) of hotel room cleaners reported severe/very severe shoulder pain in the prior 4-weeks. The sample was female (98%), Latina (78%), married/partnered (69%), born outside the USA (85%), and age 41. On average, participants had worked as a room cleaner 8 years, 40 hours per week, and made 19 beds/day. In fully adjusted models, job strain and iso-strain were not associated with shoulder pain, but ERI was: those with an ERI score greater than 1.0 had 3 times the odds of reporting shoulder pain, after adjusting for age, care-giving at home, height, years worked as a room cleaner, hours worked/week, beds made/day, physical workload, and work intensification and ergonomic indices (AOR 2.99, 95% CI 1.93-4.59,  $p=0.000$ ).

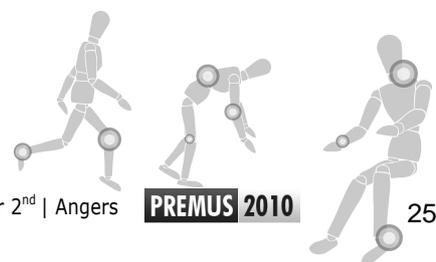
### **Conclusion:**

There is a high prevalence of shoulder pain in this population, similar to back and neck pain prevalence (Krause et al., 2005). ERI is independently associated with shoulder pain in hotel room cleaners, who were primarily female, immigrant, Latinas working in five unionized hotels in Las Vegas, Nevada, USA. Occupational health professionals should recognize the associations between psychosocial work factors and shoulder pain. Creative job design and an enhanced reward system for room cleaners may help to achieve balance between effort and rewards of work.

**Keywords:** Psychosocial factors, Vulnerable workers, Upper limb

### **Reference:**

Krause, N. et al. (2005). Physical workload, work intensification, and prevalence of pain in low wage workers: results from a participatory research project with hotel room cleaners in Las Vegas. *AJIM*



## WORKPLACE SOCIAL CAPITAL AND WORK-RELATED REPETITIVE STRAIN INJURY IN CANADA: A CROSS-SECTIONAL ANALYSIS

KRISTMAN V.L., VAFAEI A.

*Centre of Research Expertise in Improved Disability Outcomes, Toronto Western Research Institute, University Health Network, Toronto, Canada*

### Aims:

The majority of previous research on social capital and health is limited to social capital in residential neighborhoods and communities. However, recent research from the Finnish Public Sector Study has shown workplace social capital to be associated with poor general health,[1] co-occurrence of lifestyle risk factors,[2] and depression.[3] The aim of this study was to determine the association between workplace social capital and work-related repetitive strain injury.

### Methods:

Data collected from the 2005 Canadian Community Health Survey were used to measure the occurrence of injury among respondents who were working in the past 12 months. Injury outcome included 1400 repetitive strain injuries at work within the past year. Two comparison groups were used: (1) a non-work related injured group; and (2) a non-injured control group. High, medium or low workplace social capital was determined by responses to three questions about (1) hostility or conflict within the workplace; (2) supervisor helpfulness; and (3) co-worker helpfulness. Covariates considered and controlled for included demographic, health status, behaviour, physical and psychosocial job factors, and employment status factors.

### Results:

Females reporting high social capital at work had significantly decreased odds of work-related repetitive strain compared to those reporting low social capital (OR = 0.36; 95% CI: 0.15, 0.86) using the first comparison group. No difference was found in males. When injured workers were compared to those who did not have a repetitive strain injury at all, both males and females reporting high social capital at work were less likely to report a work-related repetitive strain injury than those reporting low social capital at work (female OR = 0.45; 95% CI: 0.32, 0.63; male OR = 0.64; 95% CI: 0.43, 0.96).

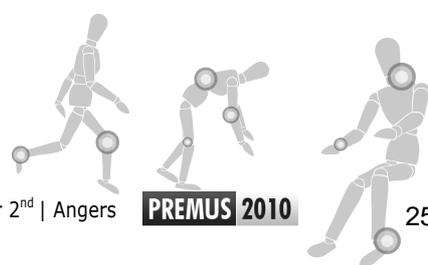
### Conclusion:

This study provides evidence for an association between workplace social capital and repetitive strain injury at work. The association was more apparent in females than in males. Workplaces employing large numbers of female workers at risk of repetitive strain may want to consider focusing on the development of programs to increase social capital in the workplace. However, future studies need to examine this association prospectively to establish the causality of the association.

**Keywords:** Psychosocial factors, Epidemiology, Social aspects of MSD

### References:

- Oksanen T, Kouvonen A, Kivimäki M, et al. Social capital at work as a predictor of employee health: multilevel evidence from work units in Finland. *Social Science & Medicine* 2008;66:637-49.
- Väänänen A, Kouvonen A, Kivimäki M, et al. Workplace social capital and co-occurrence of lifestyle risk factors: the Finnish Public Sector Study. *Occupational and Environmental Medicine* 2009;66:432-7.
- Kouvonen A, Oksanen T, Vahtera J, et al. Low workplace social capital as a predictor of depression: the Finnish Public Sector Study. *American Journal of Epidemiology* 2008;167:1143-51.



## EXPOSURE TO WORKPLACE PSYCHOSOCIAL FACTORS AND CHRONIC LOW BACK PAIN IN HOSPITAL WORKERS

D'ERRICO A.<sup>1</sup>, VIOTTI S.<sup>2</sup>, BARATTI A.<sup>3</sup>, MOTTURA B.<sup>3</sup>, CONVERSO D.<sup>2</sup>

<sup>1</sup> Epidemiology Unit, ASL TO3, Grugliasco, Piedmont Region, Italy – <sup>2</sup> Department of Psychology, University of Turin, Italy – <sup>3</sup> Occupational Medicine Unit, ASL CN1, Savigliano, Piedmont Region, Italy

### Aims:

To examine the relationship between the presence of chronic low back pain (CLBP) and exposure to workplace psychosocial factors among hospital workers.

### Methods:

Within an Occupational Health Surveillance Programme conducted in three small-size hospitals, 279 health care workers (women: 83%) filled in a questionnaire during 2007-2008 on the presence of low back pain and exposure to various workplace psychosocial factors (autonomy, organizational justice, supervisor support, climate in the working group, quality of working procedures, work-family conflicts). Subjects reporting pain in the lumbar region were also examined by an occupational physician, who ascertained the presence of CLBP, based on a set of anamnestic and clinical criteria. Through the questionnaire, information was also collected on several potential confounders of the association investigated, including exposure to workplace ergonomic risk factors, socio-demographics (age, sex, educational level, marital status, tenure position, seniority in the health care sector, in the job title and in the department), mental health, burnout (emotional exhaustion, depersonalization, personal accomplishment). Relative risks of CLBP were estimated by prevalence rate ratios obtained from Poisson regression models with the Huber-White sandwich estimator of variance (Barros and Hirakata, 2003), examining the role of psychosocial exposures as categorical variables in three levels. At first, the effect of each covariate alone was evaluated adjusting for age and gender. Afterwards, a multivariable model was fitted using a forward procedure, in which variables were added in rank order of their significance at the previous step, selecting those with  $p < 0.05$

### Results:

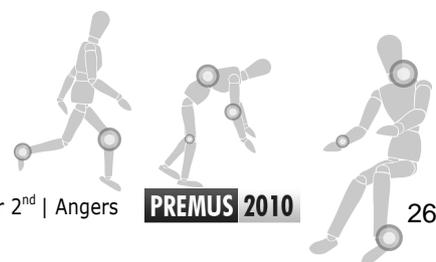
84 out of 279 workers (30%) were classified as affected by CLBP; in approximately 40% of cases, duration of symptoms was more than 5 years. In age-gender adjusted analyses, CLBP prevalence was significantly associated with high emotional exhaustion, poor mental health, high work-family conflicts, low organizational justice, and frequent exposure to several ergonomic factors. In final multivariable analysis, low organizational justice was the only psychosocial exposure significantly increasing the risk of CLBP, together with age, poor mental health, frequent stooping for a prolonged time and frequent bending and twisting with the trunk.

### Conclusion:

The results of this study suggest that exposure to low organizational justice may increase the risk of CLBP among health care workers. However, the cross-sectional design of the study, the self-reported nature of the exposure and the long duration of symptoms in an important proportion of cases limit the interpretability of the observed association as a causal one.

### Reference:

Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol* 2003; 3: 21.



## THE ROLE OF PSYCHOSOCIAL FACTORS AND SLEEP QUALITY FOR WORK-RELATED MUSCULOSKELETAL PAIN IN THE SUBWAY WORKERS BY SHIFT WORK

CHOI S.J., JEON H.J., NOH S.K., SHIN D.H., LEE M.Y.

*Department of occupational and environmental medicine, Keimyung University, Daegu, Korea*

### Aims:

This study examined the relationship between the work-related musculoskeletal pain and psychosocial factors by shift work.

### Methods:

Self-administered questionnaires including Nordic Musculoskeletal Questionnaire, Korean Occupational Stress Scale-Short Form, Psychosocial Well-being Index-Short Form, Pittsburg Sleep Questionnaire, general characteristics, life-styles, work related factors were given to a total 1426 subway workers and the qualified questionnaires were 1174. Of 1174, 469 were excluded whose disease might affect musculoskeletal pain or who sustained injury in a car accident or during exercises and received treatment. Total 705 male workers(49.4%) were analyzed using the SPSS(ver 17.0) program. The multiple logistic regression analysis was used to assess the relationship between risk factors which include psychosocial stress, job strain, sleep quality and confounding factors.

### Results:

14.3% of the subjects had musculoskeletal pain. Musculoskeletal pain was significantly higher in no-shift workers(N=44, 19.7%) than in shift workers(N=57, 11.8%) ( $p=0.01$ ). The odds ratios for musculoskeletal pain, in no-shift workers with mild stress state and high risk state of psychosocial stress at baseline were 3.15(CI: 0.71-14.02) and 4.44(CI: 0.90-21.88), and in shift workers with mild stress state and high risk state of psychosocial stress at baseline were 2.58(CI: 0.60-11.08) and 10.00(CI: 2.24-44.70) respectively. The odds ratios for musculoskeletal pain, high risk group of job strain at baseline were 1.50(CI: 0.59-3.82) in no-shift workers and 2.55(CI: 1.45-4.47) in shift workers. On multiple logistic regression analysis by adjustment for age, education, smoking, alcohol drinking, exercise, work related factors, in no-shift workers mild stress state and high risk state of psychosocial stress at baseline were 4.20(CI: 0.88-20.01) and 6.34(CI: 0.97-41.30) and in shift workers were 1.83(CI: 0.40-8.27) and 4.98(CI: 0.97-25.47) respectively, and high risk group of job strain at baseline were 0.99(CI: 0.30-3.35) in no-shift workers and 1.42(CI: 0.72-2.78) in shift workers. However in shift workers, sleep quality expressed statistically significant effects on the musculoskeletal pain both univariate logistic regression analysis(OR: 3.60, CI: 1.98-6.56) and multivariate logistic regression(OR: 2.55, CI: 1.31-4.98).

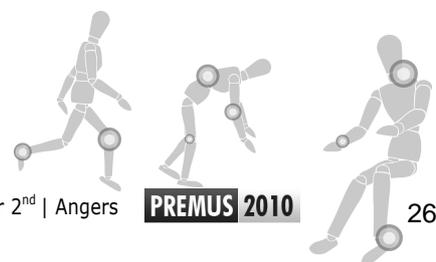
### Conclusion:

Overall, the relationship between musculoskeletal pain and the psychosocial factors was not significant. Sleep quality were significantly associated with musculoskeletal pain in shift workers.

**Keywords:** Specific sectors, psychosocial factors, other

### References:

- Catarina Canivet, Per-Olof Östergren, Bongkyoo Choi, Peter Nilsson, Ulrika af Sillén, et al. Sleeping Problems as a Risk Factor for Subsequent Musculoskeletal Pain and the Role of Job Strain: Results from a One-Year Follow-Up of the Malmö Shoulder Neck Study Cohort. *International Journal of Behavioral Medicine*, 15: 254–262, 2008.
- J. McBeth, A. J. Silman, A. Gupta, Y. H. Chiu, D. Ray, R. Morriss, C. Dickens, Y. King, and G. J. et al. Moderation of psychosocial risk factors through dysfunction of the hypothalamic-pituitary-adrenal stress axis in the onset of chronic widespread musculoskeletal pain: findings of a population-based prospective cohort study. *Arthritis & Rheumatism*, Vol. 56, No. 1, January 2007, p 360–371
- Chang SJ, Koh SB, Kang D, Kim SA, Kang MG, Lee CG et al (2005) Developing an occupational stress scale for Korean employees (in Korean). *Korean J Occup Environ Med* 17:297–317



## INTERACTIONS OF BIOMECHANICS AND PSYCHOSOCIAL STRESSORS IN RELATION TO THE DEVELOPMENT OF MSDS IN THE MODERN OFFICE: THE 'PROOF' STUDY PROTOCOL

EIJCKELHOF B.H.W.<sup>1,2</sup>, HUYSMANS M.A.<sup>1,2</sup>, BLATTER B.M.<sup>2,3</sup>, BRUNO J.L.<sup>4</sup>, JOHNSON P.W.<sup>5</sup>, VAN DER BEEK A.J.<sup>1,2</sup>, VAN DIEËN J.H.<sup>6</sup>, DENNERLEIN J.T.<sup>4</sup>

<sup>1</sup> Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands - <sup>2</sup> Body@Work, Research Center on Physical Activity, Work and Health TNO-VU/VUmc, The Netherlands - <sup>3</sup> TNO Quality of Life, Hoofddorp, The Netherlands - <sup>4</sup> Harvard School of Public Health, Department of Environmental Health, Boston, USA - <sup>5</sup> University of Washington, Seattle WA, USA - <sup>6</sup> Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, Amsterdam, The Netherlands.

### Aims:

Until now, most research in computer workers focuses either on experimental studies measuring detailed biomechanics in the laboratory or on large scale epidemiological studies investigating exposure and the occurrence of symptoms using self-reports. Combining biomechanical exposure assessment with large scale epidemiology is important and challenging.

The aims of the present study are to investigate 1) whether biomechanical exposures and computer use differ in computer workers with different psychosocial profiles while measured at work, and 2) whether biomechanical exposures and psychosocial factors are related to an increased risk of upper extremity MSDs.

### Methods:

In the PROOF (PRedicting Occupational biomechanics in OFFice workers) study 120 office workers will be categorized in one of four defined profiles of psychosocial work environment, based on the amount of "Reward" one receives at work and their reported level of "Overcommitment" (both collected through a questionnaire). Biomechanical exposures (i.e. forces on keyboard and mouse, postural dynamics, and EMG of Trapezius and wrist extensors) and computer usage will be continuously and synchronously measured for two hours during a workday at participants' own work station. These biomechanical factors will be compared across the four psychosocial profiles.

With these data a task-based exposure model will be developed to estimate the average and cumulative biomechanical exposures within different psychosocial work environments adjusted for individual factors. This model will be applied to a cohort of about 1000 office workers, of whom computer usage was assessed objectively and health outcome was self-reported in a two-year longitudinal study (PROMO). In this way, we will be able to relate biomechanical exposure to the development of MSDs measured in a large epidemiological study.

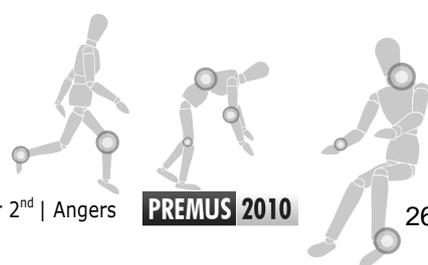
### Results:

Data collection started in January 2010. No results are available yet.

### Conclusion:

The obvious strength of this study is that we will be able to test for relationships between psychosocial factors and physical factors assumed to increase the biomechanical loads on the tissues, both measured in the field within the workers' own working environment. In addition, based on these measurements on 120 workers, relationships between the physical factors estimated from these biomechanical measurements and the incidence of upper extremity MSDs in larger population of office workers will be assessed. Potential weaknesses may be lack of representativeness with regard to the psychosocial status of the participants and their computer usage, due to the fact that they will be measured only once.

**Keywords:** Postures, physical exposure, computer work, psychosocial factors



## ROLE OF PSYCHOSOCIAL FACTORS IN MUSCULOSKELETAL DISORDERS IN THE TUNISIAN TEXTILE INDUSTRY WORKERS

HENCHI M.A., AMRI C., MAHFOUDHI A., BOUZGARROU L., MERCHAOU I., CHEIKH MHAMED A., KRAIEM R., GAALICHE A., AKROUT M., KHALFALLAH T.

*Laboratory of Occupational Medicine and Ergonomics - Medical College of Monastir – Tunisia*

### Aims:

In professional environment, musculoskeletal disorders are increasingly frequent and have a significant human and socio-professional impact. Parallel to the biomechanical risk factors, the psychosocial factors constitute a current event. The purpose of the study is to analyze the interactions between the psychosocial risk factors and the musculoskeletal complaints.

### Methods:

It is a descriptive cross-sectional study by questionnaire related to a representative sample of 142 female workers in a jean specialized textile company in Monastir (Tunisia). The questionnaire contains 64 items relating to general and socio-professional characteristics, health condition, perception and appreciation of the work conditions, musculoskeletal disorders and evaluation of stress by the Job content questionnaire of Karazek in its short version of 14 questions.

### Results:

The standard profile of the studied population is a woman  $29 \pm 6$  years old, single (58.5%), childless (68.3%), with a low educational level (65%). The average professional seniority was  $7 \pm 5$  years.

The prevalence of musculoskeletal disorders was: low back (67%), shoulders (61.3%), wrist (46%) and nape (41%).

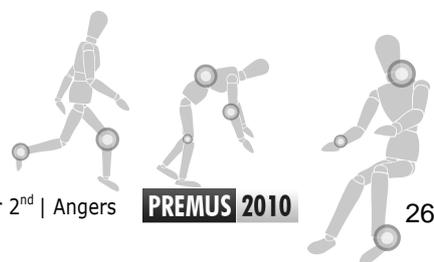
The average score of the decisional latitude is  $1.2 \pm 0.3$  with extreme going from 0.6 to 2.2. The average score of the requirement of the task is  $2.8 \pm 0.3$  with extreme going from 2.2 to 3.6. In 85.2% of the cases, the workers had weak latitude of decision and high requirement of the task (job strain).

The statistical analysis showed statistically significant relations between musculoskeletal disorders and matrimonial situation, educational level, work accidents history concerning the upper limbs. The workers stress was influenced by work station, professional seniority and number of under-aged children.

### Conclusion:

Because of their risk factors diversity, musculoskeletal disorders prevention strategy should be global, multi-field and participative. It has to be based on an ergonomic plan centered, not only on biomechanics constraints but also work psycho organisational factors.

**Keywords:** Specific sectors, Psychosocial factors, Social aspects of MSD



## IS EMOTIONAL DEMANDS A RISK FACTOR FOR MUSCULOSKELETAL COMPLAINTS AMONG HEALTH CARE WORKERS?

HOLTE K.A., LABRIOLA M., LUND T., KNARDAHL S.

*International Research Institute of Stavanger, Norway.*

### **Aims:**

The last decade the nature of work have changed from production of goods to service and focus on client demands. Although few studies exist, indications of a possible association between emotional demands related to the contact with clients and musculoskeletal pain exists (Elovainio & Sinervo 1997, Gonge et al 2002, Holte & Westgaard 2002). The aim of this study is to explore if two aspects of client work, namely demands for showing positive emotions and emotional dissonance is associated with neck pain and shoulder pain.

### **Methods:**

The study sample consists of 1284 health care workers. This is a subsample drawn from the baseline data in a large Norwegian prospective questionnaire study. A logistic regression analysis with demands for showing positive emotions and emotional dissonance as exposure, neck pain and shoulder pain as outcome and age, gender, sector, occupation, working hours and manual handling of patients as covariates, were performed.

### **Results:**

The 4-week prevalence of musculoskeletal complaints in the study population was 51% for neck pain and 48% for shoulder pain. Reporting high demands for showing positive emotions showed no increased risk, neither for neck pain nor for shoulder pain. However, the logistic regression showed that always perceiving emotional dissonance, were associated with an increased risk for both neck pain and shoulder pain when controlled for background variables and manual handling of patients.

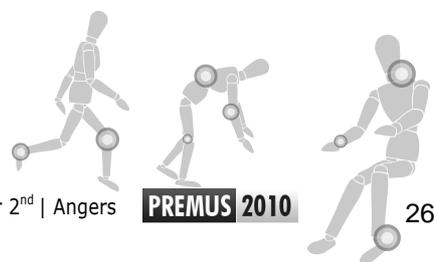
### **Conclusion:**

The study shows that emotional dissonance is associated with both neck pain and shoulder pain, also when controlling for manual handling of clients. This association should be further elaborated.

**Keywords:** Health care workers, psychosocial factors, neck

### **References:**

- Elovainio M, Sinervo T. Psychosocial stressors at work, psychological stress and musculoskeletal symptoms in the care for elderly. *Work and Stress*. 1997;11: 351-361.
- Gonge H, Jensen LD, Bonde JP. Are psychoosical factors associated with low back pain among nursing personell? *Work and Stress*. 2002; 16: 79-87.
- Holte KA., Westgaard RH., Vasseljen O. Exploring perceived tension as a response to psychosocial work stress. *Scandinavian Journal of Work Environment and Health*. 2003; 29: 124-133.



## THE PREDICTIVE EFFECT OF FEAR-AVOIDANCE BELIEFS ON LOW BACK PAIN AMONG NEWLY QUALIFIED HEALTH CARE WORKERS WITH AND WITHOUT PREVIOUS LOW BACK PAIN: A PROSPECTIVE COHORT STUDY

JENSEN J.N., ALBERTSEN K., BORG V., NABE-NIELSEN K.

*The National Research Centre for the Working Environment, Copenhagen, Denmark*

### **Aims:**

Health care workers have a high prevalence of low back pain (LBP). Although physical exposures in the working environment are linked to an increased risk of LBP, it has been suggested that individual coping strategies, for example fear-avoidance beliefs, could also be important in the development and maintenance of LBP. Accordingly, the main objective of this study was to examine (1) the association between physical work load and LBP, (2) the predictive effect of fear-avoidance beliefs on the development of LBP, and (3) the moderating effect of fear-avoidance beliefs on the association between physical work load and LBP among cases with and without previous LBP.

### **Methods:**

A questionnaire survey among 5696 newly qualified health care workers who completed a baseline questionnaire shortly before completing their education and a follow-up questionnaire 12 months later. Participants were selected on the following criteria: (a) being female, (b) working in the health care sector (n = 2677). Multinomial logistic regression analysis was used to evaluate the effect of physical work load and fear-avoidance beliefs on the severity of LBP.

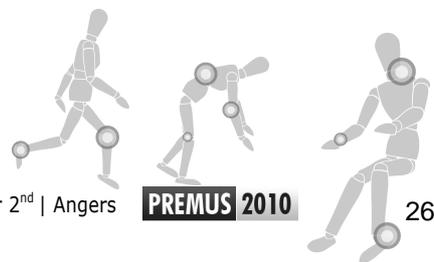
### **Results:**

For those with previous LBP, physical work load has an importance, but not among those without previous LBP. In relation to fear-avoidance beliefs, there is a positive relation between it and LBP of than 30 days in both groups, i.e. those without and with previous LBP. No moderating effect of fear-avoidance beliefs on the association between physical work load and LBP was found among cases with and without LBP.

### **Conclusion:**

Both physical work load and fear-avoidance beliefs matters in those with previous LBP. Only fear-avoidance beliefs matters in those without previous LBP. The study did not find a moderating effect of fear-avoidance beliefs on the association between physical work load and LBP.

**Keywords:** Health care workers, psychosocial factors



## WHICH JOB CONSTRAINTS ARE LINKED TO 'TROUBLE IN WORK' AMONG EMPLOYEES SUFFERING FROM BACK PAIN?

LEROYER A.1, MOLINIE A.F.2, POMMIER J.L.3, AL KADIRI K.4, VOLKOFF S.2 AND THE EVREST NATIONAL PROJECT TEAM MEMBERS

<sup>1</sup> Université Lille 2 Occupationnal Health Department, Lille, France - <sup>2</sup> CEE/CREAPT, Noisy-le-Grand, France - <sup>3</sup> DRTEPF Poitou-Charentes, Poitiers, France - <sup>4</sup> Institut de Santé au Travail du Nord de la France, Lille, France.

### Aims:

Risk factors of back pain among employees are well known. However, little is known about factors related to 'trouble in work' linked to back pain among employees, which constitute the aim of this work.

### Methods:

Data were extracted from the French national database 'Evrest', constituted by questioning employees born in October of even years by their occupational health doctor, during the periodic visit. 'Evrest' is a monitoring system, based on a two pages questionnaire, the aim of which is the dynamic study of various aspects of employees' work and health. Responses collected by the medical doctor were provided by the self-assessments of the employees about their working conditions and health. In 2007-2008, 537 voluntary occupational health doctors were involved in the data collection, and cumulated 12526 questionnaires. Back pain was defined as employees' complaints localized at the dorsal or lumbar level, during the periodic visit; if employees experienced back pain, the medical doctor requested if this problem generates 'trouble in work'. Various aspects of work were studied, chosen in the field of working time, time constraints, psychosocial features of the work situation, and physical constraints. Comparisons on the effects of age and occupational constraints between employees with 'pain only', and employees with back pain and 'trouble in work' were conducted through a multinomial logistic regression; in every model we studied men and women separately, and adjusted on body mass index.

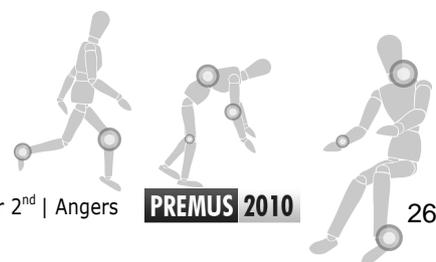
### Results:

Complete back pain information concerned 12035 questionnaires (96%). Among the 5114 women, 448 experienced 'back pain only' (8.8%), and 626 cumulated back pain and 'trouble' linked to it (12.2%); among the 6921 men, the numbers and percents of employees concerned were respectively 665 (9.6%) and 925 (13.4%). For women, age over 50 years and postural constraints (OR=1.50 CI95%[1.18-1.90]) were linked with 'pain only', while, in addition, many aspects of work were linked with pain associated with 'trouble in work' (including: work does not give opportunities to learn OR=1.41 [1.14-1.76], lack of mutual aid at work OR=1.28 [1.02-1.62]). Differences between the 2 groups of back pain among men show similar profiles.

### Conclusion:

Hence, it seems that some modifications in work organization could allow more employees with back pain to keep on working without experiencing trouble in work, and thus to avoid the risk of job loss.

**Keywords:** Work organization, back, low back, pain, chronic pain



## **SENSE OF COHERENCE, HEALTH BEHAVIORS, FAMILY STRESS AND BACK PAIN AMONG STUDENTS**

MALINAUSKAITE I.

*Kaunas University of medicine, Lithuania*

### **Aims:**

Musculoskeletal disorders are widely spread not only among adults, but among adolescents as well. Not only physical factors play an important role in the etiology of musculoskeletal disorders. Psychosocial factors, stress and unhealthy life style are of great importance. On the other hand, individual's internal resources and coping strategies are very important in pain perception. The aim of our study was to assess the level of sense of coherence, prevalence of unhealthy life style and family stress indices among 5-9 grades' students in the Kaunas city, Lithuania, and to evaluate the associations between low sense of coherence and low back pain.

### **Methods:**

The study was conducted among the randomly selected 5-9 grades' students in the schools of Kaunas city. 291 students participated in the interview (response rate 82.6%). Sense of coherence was measured by the 13-item Antonovsky's sense of coherence scale. We evaluated the experience of family crisis (parents' divorces, serious financial problems in the family, incurable disease or death of a close relative) over the last twelve months. The statistical software SPSS 13.0 for Windows was used. The logistic regression analysis was performed for the estimation of the adjusted OR for back pain and sense of coherence, controlling for age, gender, health behaviors (smoking, alcohol, and leisure time physical activity), self-rated health, stress family stress, crisis in the family.

### **Results:**

The prevalence of back pain was 17.9%. Family stress experienced 5.9% of the investigated students, severe family crisis – 13.1%, low sense of coherence 6.4%. Crude OR of low sense of coherence for back pain was 3.66; 95% CI 1.16-12.81, after adjustment for age, gender unhealthy life style, self-rated health, stress, severe family crisis and family stress, it increased to 4.98; 95% CI 1.09-22.81. Severe family crisis significantly increased the risk for low back pain by 3.06-fold (95% CI 1.17-8.02) among students.

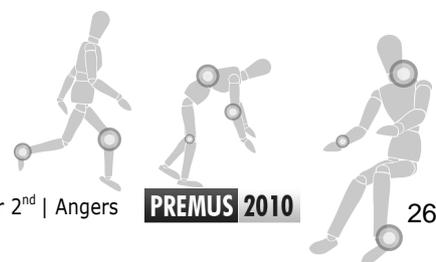
### **Conclusion:**

Low sense of coherence is an important determinant of pain perception. Students with low sense of coherence were at higher risk of low back pain. Family stress played an important role in the etiology of low back pain. Preventive strategies should be implemented towards increasing coping abilities among students.

**Keywords:** Psychosocial factors, Personal risk factors for MSD, Back, Low back

### **References:**

- Oztekin C, Tezer E. The role of sense of coherence and physical activity in positive and negative affect of Turkish adolescents. *Adolescence*. 2009;44(174):421-32.
- Stankūnas M, Kalediene R, Starkuviene S. Sense of coherence and its associations with psychosocial health: results of survey of the unemployed in Kaunas. *Medicina (Kaunas)*. 2009;45(10):807-13.



## THE ASSOCIATIONS BETWEEN WORK AND FAMILY PSYCHOSOCIAL FACTORS AND MUSCULOSKELETAL PAIN AMONG NURSES

MALINAUSKIENE V., DACKUTE A.

*Kaunas University of Medicine, Institute of Cardiology, Lithuania*

### **Aims:**

Recent studies have confirmed that not only ergonomic factors, but psychosocial factors at work play an important role in the occurrence of musculoskeletal pain among nurses. The aim of our study was to investigate the associations between musculoskeletal pain and work and family psychosocial factors among nurses.

### **Methods:**

A random sample of the Lithuanian community nurses was investigated (N=372). The Job Content questionnaire was used to evaluate the level of job demands, job control and social support at work. Workplace bullying was measured by Negative Acts Questionnaire (H Hoel & S Einarsen). Threatening life events were assessed over the last 12 months. In the analysis prevalence of pain (low back and neck/shoulder) during the previous 12-months period was used.

### **Results:**

Neck/shoulder pain among nurses was associated with severe bullying (OR=5.45; 95% CI 1.41-21.01), high job demands (OR=3.29; 95% CI 1.84-5.89), low job control (OR=1.86; 95% CI 1.10-3.07), threatening life events (OR= 1.84; 95% CI 1.10-3.07) after adjustment for age, smoking, alcohol, heavy lifting at work, shift work, leisure time physical activity. Low back pain was associated with threatening life events (OR=2.36; 95% CI 1.30-4.30), smoking (OR=2.62; 95%CI 1.35-5.09).

### **Conclusion:**

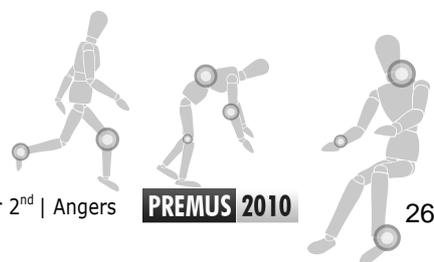
Our findings suggest that musculoskeletal pain among nurses is associated with work and family psychosocial factors. The need for preventive measures against workplace bullying and work organization as well as strengthening internal resources is in charge.

**Keywords:** Psychosocial factors, Back, Low back, Neck

### **References:**

Leijon O, Mulder M. Prevalence of low back pain and concurrent psychological distress over a 16-year period. *Occup Environ Med.* 2009;66:137-9.

Antonopoulou MD, Alegakis AK, Hadjipavlou AG, Lionis CD. Studying the association between musculoskeletal disorders, quality of life and mental health. A primary care pilot study in rural Crete, Greece. *BMC Musculoskeletal Disord.* 2009;10:143.



## APPLICATION OF A COMPREHENSIVE MODEL (MODSI) FOR THE RISK ASSESSMENT OF MUSCULOSKELETAL DISORDERS

MANERO R., SOTO L., RODRIGUEZ T.

*Centro de Investigaciones Ergológicas. Universidad de Carabobo. Valencia. Venezuela.*

### Aims:

A comprehensive Model (MODSI) was designed to assess the risk of developing musculoskeletal disorders (MSD), evaluating not only the elements that comprise the biomechanics labour demands –strength, posture, repetition– but also studying the worker's physiological and psychosocial aspects and referring to the physical environment that surround the work place

### Methods:

MODSI was applied to a total of 101 workers who performed tasks in 37 different work areas: Automotive-10, Paper Industry-11, Distribution of Soft Drinks-10, Aluminium Industry-6. With this instrument we analysed the posture of the different body parts and considered other factors such as applied force, repetitiveness, coupling, vibration, incorrect alternation and permanence in the evaluated posture. For such purposes, the activities were filmed in real time and the image was analysed with periodic and systematic pauses (1). Physiological behaviour was assessed by measuring the heart rate (HR) using an electronic sensor. The cost cardiac true index (CCTI) was subsequently calculated (2). The perceived exertion (PE) of each worker was evaluated using the Borg scale (3). The Psychosocial Factors (SPF) such as initiative, social status and identification with the activity were also considered. These applications also allow evaluating the applicability of the Model as well as the integral behaviour of all the indicators that it comprise.

### Results:

Over 50% of the tasks evaluated (20 tasks) had a high level of risk to their workers suffer MSD. In the 37 tasks analyzed, the CCTI and PE matched in 65% of cases and the rest of the workers (35%) reacted with a higher perceived exertion than cardiovascular response. Workers in 23 of the tasks performed showed negative effects on the tested SPF. The risks levels detected by the application of the model had a significant association (P

### Conclusion:

The application of the Model revealed the risks of suffering MSD by the workers in question, identifying the different factors that may cause the occurrence of these disorders. Moreover, the Model is a proposal that considers the human side of the worker, involving the employee through their physiology, his perception of work and their social relationships within his own working reality.

**Keywords:** Psychosocial factors, Exposure measurement methods, Intervention studies

### References:

Keyserling W.M. Postural analysis of the trunk and shoulders in simulated real time. *Ergonomics*.  
Manero R. Armisen A. Manero J. Métodos prácticos para estimar la capacidad física de trabajo. *Bol*  
Borg G. Physophysical scaling with applications in physical work and the perception of exertion. *Scan*



## DOES THE WORK STYLE CONTRIBUTE TO MUSCULOSKELETAL SYMPTOMS IN INDIAN COMPUTER PROFESSIONALS?

SHARAN D., AJEESH P.S., RAMESHKUMAR R., JEENA J., MATHANKUMAR M.

*Recoup neuromusculoskeletal rehabilitation centre, Bangalore, India*

### Aims:

The work style model is based upon the hypothesis that how a worker performs his/her work tasks in reaction to increased work demands may contribute to the etiology, exacerbation, and/or maintenance of Work Related Musculoskeletal Disorders (WRMSDs). The aim of this study was to investigate the relationship between self reported musculoskeletal symptoms and the work style in Indian computer professionals.

### Methods:

A questionnaire survey was conducted among 4511 Indian computer professional using a musculoskeletal survey form and the short work style form. The median age of patients was 28.5±6 years and males accounted for 76%. 76% were desktop users, 19% laptop users and 5% used both. The duration of the study was 6 years (2004- 2009).

### Results:

2958 (65.6%) reported pain while working or shortly after working. In 25.8%, the pain disappeared completely when the respondent stopped working; in 44.3% the pain disappeared completely by next morning; while 58.8% were completely pain free on Monday morning if they had Sunday off. Other symptoms were difficulty in falling asleep (40.2%), tingling, numbness or cold fingers (35.1%), weakness of arms or hands (34.7%), strain/fatigue of the eyes (34.7%). Regional distributions of symptoms were lower back (54.2%), neck (49.7%), shoulder (47.2%) and thighs, knee, legs or feet (36.8%). 29.2% reported that their productivity or quality of work had deteriorated because of their symptoms. 67.8% of laptop users reported musculoskeletal symptoms compared to 65.2% of desktop users. The work style was assessed to be a risk in 28.2% (Desktop 29.11%, Laptop 22.67% and both 36.57%). Major work style risk factors were working though pain (mean=5.13), deadline/support (mean=2.52), social reactivity (mean=2.31), lack of break (mean =2.14), limited work place support (mean=2.06) and self imposed work (mean=1.85). Mean values of work style risk factors in the group with musculoskeletal pain were significantly more when compared with the group without pain.

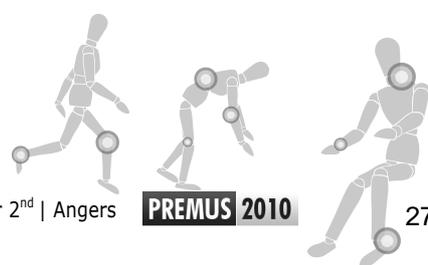
### Conclusion:

The study concluded that the Work Style contributed to Musculoskeletal Symptoms. The major work style risk factors were working though pain, deadline/support and social reactivity. These findings suggest work style may be a potential focus of WRMSD prevention efforts.

**Keywords:** Mechanism of pain and tissue injury, computer work, psychosocial factors

### References:

1. Janwantanakul P, Pensri P, Jiamjarasrangsri W, Sinsongsook T. Associations between prevalence of self-reported musculoskeletal symptoms of the spine and biopsychosocial factors among office workers. *J Occup Health* 2009; 51(2): 114-22.
2. Harrington CB, Siddiqui A, Feuerstein M. Workstyle as a predictor of pain and restricted work associated with upper extremity disorders: a prospective study. *J Hand Surg Am.* 2009 Apr; 34(4): 724-31.
3. Feuerstein M, Nicholas RA. Development of a short form of the Workstyle measure. *Occup Med (Lond).* 2006 Mar; 56(2): 94-9.



## COMPUTER WORK

### REDESIGNING THE KEYBOARD SPACEBAR CAN IMPROVE WRIST POSTURE WHILE TYPING

ODELL D.L., LEE D.L.

*Microsoft Corporation, Redmond, Washington, USA*

#### Aims:

Computer typists are exposed to postural risk factors such as prolonged wrist ulnar deviation, which may contribute to the development of typing-related musculoskeletal disorders (Serina et al., 1999). Since the left wrist typically displays less ulnar deviation than the right while typing (Serina et al., 1999), and it has been observed that the right thumb is used to strike the spacebar much more commonly than the left (Baker et al., 2007), the difference in spacebar usage could be contributing to the difference in wrist posture. Therefore, the present work examined the hypothesis that spacebar design can affect wrist posture through a process of 1) locating the natural resting position of the thumb on the keyboard, 2) designing a new spacebar to accommodate that location, and 3) experimentally comparing typing wrist posture between the new spacebar design and a traditional design.

#### Methods:

To find the natural resting position of the thumb on the keyboard, twenty touch-typists held their palms approximately three inches over the keyboard, and placed the four fingers of their right hands on the home row. With a neutral wrist posture and without looking, the typists relaxed their hands, and lowered their palms onto the keyboards. 75% of thumbs missed the conventional spacebar, instead landing towards the palmrest. This suggested that the conventional spacebar was not in the ideal position for neutral posture, and is too far from the palmrest. The effect is that these users must reach to actuate the spacebar, resulting in wrist ulnar deviation.

To address this, a double-wide spacebar that extended toward the palmrest by an extra 19 mm was built. Ten touch-typists then completed a standardized typing task on two otherwise identical keyboards: one with the alternative spacebar and another with the conventional spacebar. Electrogoniometers (Greenleaf Medical Wrist System) were used to measure bilateral wrist posture during the task. Users were instructed to use the lower edges of the alternative spacebar as they typed.

#### Results:

Compared to the conventional spacebar, the alternative design reduced right wrist deviation by 3.2 degrees ( $p < 0.05$ ). No significant difference in the left wrist posture was found. Subjectively, participants preferred the alternative spacebar.

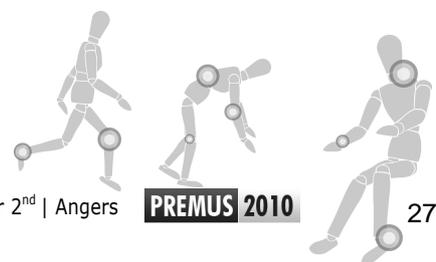
#### Conclusion:

Keyboard spacebar design has a significant effect on right wrist posture. Spacebars that extend closer to the palm can reduce right wrist deviation while typing. The implication is that by better matching the spacebar strike location to the relaxed hand, keyboard designers have the possibility to reduce postural risk factors associated with typing-related musculoskeletal disorders.

**Keywords:** Postures, physical exposure, Computer work, Upper limb

#### References:

Baker NA, Cham R, Cidboy E, Cook J, Redfern MS: "Kinematics of the fingers and hands during computer keyboard use," *Clinical Biomechanics* 22(1):34-43, 2007.  
Serina ER, Tal R, Rempel D: "Wrist and forearm postures and motions during typing"



## DIFFERENCES IN MUSCLE LOAD BETWEEN COMPUTER AND NON-COMPUTER WORK AMONG OFFICE WORKERS

RICHTER J.M.<sup>1,2</sup>, MATHIASSEN S.E.<sup>2</sup>, SLIJPER H.P.<sup>1</sup>, FRENS M.A.<sup>1</sup>

<sup>1</sup> Erasmus MC, Rotterdam, the Netherlands – <sup>2</sup> Centre for Musculoskeletal Research (CBF), University of Gävle, Sweden

### Aims:

Extensive computer use has been related to musculoskeletal complaints (MSC) because of the prolonged periods of sustained muscle activation with little variation in exposure (Mathiassen 2006). Introduction of more breaks has been suggested to increase exposure variation and thus reduce MSC. This study investigated whether muscle activity did, indeed, differ between computer and non-computer activities.

### Methods:

Whole-day logs of input device use in 30 office workers were used to identify computer and non-computer work, using a range of classification thresholds called 'non-computer thresholds' (NCTs), see Richter et al. (2008). The NCT influences the total amount of computer work by classifying more or less computer events as computer work. The higher the NCT, the higher the amount of computer work. So far, however, no studies have concerned to which extent 'computer' and 'non-computer' work differ in biomechanical exposure for different NCTs. Therefore, the choice of a NCT has been arbitrary, and the significance of the information obtained by registration software unknown. In parallel with the input device recording, whole-day bilateral electromyography recordings were obtained from the upper trapezius and extensor and flexor carpi radialis.

### Results:

Depending on the NCT, non-computer activities could consist of, e.g. paper work, meetings or breaks. Actual non-computer activities differed among participants, although none of the office workers left the office building during the measurement or performed high-intensity activities such as sports. Differences in muscle activity, as quantified by a contrast measure, between computer and non-computer work were distinct but small for all muscles, even at the individualized, optimal NCT where the contrast measure was maximal. This was mainly caused by the large within-subject variability of muscle activity during non-computer work episodes. Furthermore, using an average group-based NCT for each individual resulted in less contrast, even in smaller subgroups defined by job function or MSC.

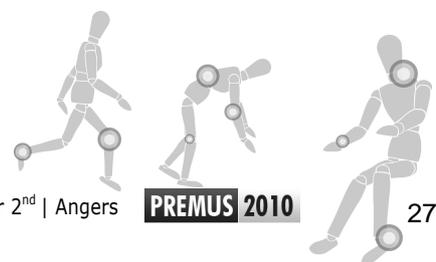
### Conclusion:

These results indicate that registration software may provide limited information on muscle activity patterns during daily computer use, and that computer activity logs should thus be used cautiously as proxies of biomechanical exposure. Conventional non-computer tasks may have a limited potential to increase variation in muscle activity during computer-intensive office work. More vigorous physical activity, such as organized physical exercise at work or taking the stairs, would have a substantially larger effect in creating an office job with adequate variation in muscle activity.

**Keywords:** Muscle activity, Computer work, Exposure measurement methods.

### References:

Mathiassen SE. Diversity and variation in biomechanical exposure: what is it, and why would we like to know? *Applied Ergonomics*. 2006; 37 (4): 419-27.  
Richter JM, Slijper HP, Over EAB, Frens MA. Computer use duration and its dependence on the used pause definition. *Applied Ergonomics*. 2008; 39 (6): 772-8.



## POSTURES AND TYPING STRATEGIES IN MOBILE DEVICE USAGE AS CHARACTERIZED THROUGH AN OBSERVATIONAL INSTRUMENT

GOLD J.E., THOMAS N., DRIBAN J., CHANNELL T., CHAKRAVARTY T.

*Ergonomics and Work Physiology Laboratory, Temple University, Philadelphia, Pennsylvania, USA*

### Aims:

Text messaging and other mobile device usage involving typing is increasing rapidly in the general and working populations, particularly in the white collar professional and health care sectors. Several published case studies have described ailments including de Quervain's tenosynovitis, CMC arthritis, and "Blackberry thumb" in such users. Preliminary epidemiologic research has indicated that thumb, shoulder and neck symptoms may be associated with mobile device usage (Gold, et al 2009; Wells, et al 2009). Gold, et al (2009) indicated that shoulder discomfort was associated with categorical number of daily text messages sent in males (prevalence ratio [PR] = 1.94, 95% CI: 1.22-3.06), but not in females (PR = 1.10, 95% CI: 0.76-1.60). A similar effect modification by gender was found for neck discomfort (PR = 2.52, 95% CI: 1.16-5.46, males; PR = 0.93, 95% CI: 0.6-1.43, females). Our aims were to: 1) characterize postures and typing strategies employed by college students using mobile phone devices through an observational analysis instrument, and 2) determine whether there were differences in exposure based on gender.

### Methods:

We developed the Mobile Device-Postural Assessment Tool, a portable checklist instrument, to characterize upper extremity and back postures (neutral vs. non-neutral), typing styles (specific fingers used), and input mechanisms (keyboard type and orientation). Subjects appearing college-aged (n = 600) were observed in 12 locations on or near two university campuses for one hour per day by 3 observers. Locations and start times of observations (9:00 am – 3:00 pm) were randomized.

### Results:

Our preliminary observations (n = 27) indicated that the typical posture for mobile phone typing included flexed neck and non-neutral wrists. In all cases, the texting forearm was either in neutral or in supination. Approximately half of the subjects used both thumbs for typing, and half used their right thumb only. The majority of subjects (52%) used QWERTY (rather than alphanumeric) keyboards with physical keys (rather than virtual touch screen "keys"). Exposure differences between males and females are still under investigation.

### Conclusion:

It is unknown whether the ergonomics exposures observed in student users of mobile devices differ from exposures to similar devices in the working population. However, non-neutral wrist postures and a flexed neck are known risk factors for MSDs. Further research should be done to determine whether these non-neutral postures are associated with MSD symptoms in mobile device users, particularly in work settings.

**Keywords:** Postures, physical exposure, Computer work, Gender differences

### References:

- Gold J, Kandadai V, Hanlon A. Text messaging and upper extremity symptoms in college students. American Public Health Association Conference, Philadelphia, 2009.  
Wells R, Amick B, Berolo S. Project iThumb: an approach to studying the prevalence of hand disorders among hand-held device users. International Ergonomics Association Conference, Beijing, 2009.



## KEYSTROKE DURATION SHORTENS OVER THE DAY DURING INTENSIVE COMPUTER USE: A POTENTIAL MEASURE OF KEYBOARD RELATED FATIGUE

HAN C.<sup>1</sup>, DENNERLEIN J.T.<sup>2</sup>, JOHNSON P.<sup>3</sup>, WANG Y.<sup>1</sup>

<sup>1</sup> Center for Disease Control and Prevention, Tianjin, China – <sup>2</sup> School of Public Health, Harvard University, MASSACHUSETTS, USA – <sup>3</sup> Env. and Occ. Health Sciences, University of Washington, WA, USA

### Aims:

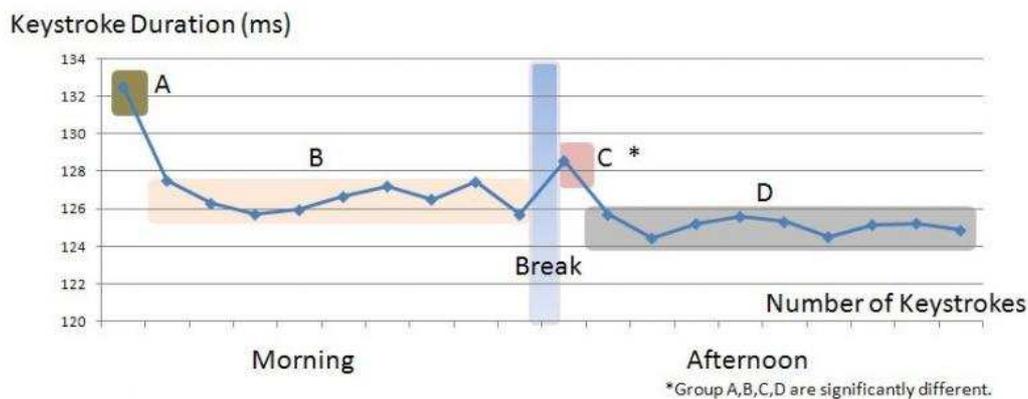
A laboratory study demonstrated that keystroke duration (KD) systematically shortened when the finger muscles were subjected to exercise and fatigued. The purpose of this field study was to follow a group of skilled computer operators and determine whether KD shortened over a full-day of computer use. The shortening of KD may be associated with fatigue related changes in the muscle resulting from the exposure to computer work.

### Methods:

Using a repeated measures design, the KD of 13 computer operators (6 male, 7 female) were collected over 4 weeks. A computer monitoring program continuously ran in the background and measured the KD of all alphabetic keystrokes. All subjects worked 8 hours a day and took a 1.5 hour lunch break between morning and afternoon. For each subject, the cumulative keystrokes in the morning and afternoon sessions were divided into 10 equal groups and analyzed using RANOVA methods to determine whether the KD shortened with cumulative keyboard use.

### Results:

Results showed that KD shortened in the morning, partially recovered after the 1.5 hour lunch break and shortened even further in the afternoon. The sharpest drops in KD occurred right after typing started, roughly during the first 20% of the keystrokes typed in the morning and afternoon. Thereafter, KD remained relatively stable. Faster typing and greater cumulative keystrokes led to greater drops in KD.



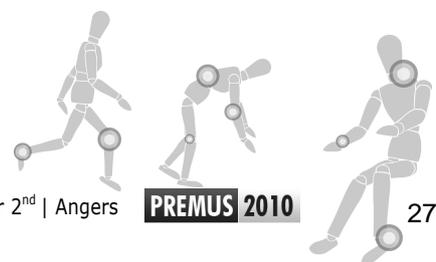
### Conclusion:

KD shortens with intensive keyboarding activity. These results from this field study were consistent with a laboratory study<sup>1</sup> that showed both keystroke and muscle twitch durations shortened when subjects' finger muscles became fatigued, indicating that these users were experiencing muscle fatigue. Monitoring for systematic changes (shortening) in KD could be a non-invasive and effective method to detect and intervene when the muscles undergo physiological changes due to exposure to computer work.

**Keywords:** Computer work, Exposure measurement methods, Early prevention.

### Reference:

Che-Hsu (Joe) Chang et al. (2009) Typing keystroke duration changed after submaximal isometric finger exercises. *European Journal of Applied Physiology*, 105(1): 93 – 101.



## THE INFLUENCE OF PERCEIVED WORK DEMANDS ON TRAPEZIUS ACTIVITY AMONG EMERGENCY CALL-CENTRE WORKERS

DELISLE A., TOULOUSE G., SALAZAR E., DUHALDE D., COMTOIS A.-S.

*Faculté d'éducation physique et sportive, Université de Sherbrooke, Sherbrooke, Canada; Institut de recherche Robert-Sauvé en santé et en sécurité du travail, Montréal, Canada; Département de kinanthropologie, Université du Québec à Montréal, Canada.*

### Aims:

Prolonged computer work in combination with high mental demands has been hypothesized to be related to shoulder and neck pain. This hypothesis has mainly been supported by laboratory studies showing a relation between muscle activity and mental stress. Such a relation has rarely been investigated in field studies. This exploratory study aimed at documenting the relationship between perceived mental stress and trapezius muscle electromyography of emergency call-center workers, who were shown to report musculoskeletal symptoms and psychological distress (Toulouse et al. 2009).

### Methods:

Six women (age: 31 - 47 years; weight: 56.7–77 kg; height: 1.60–1.70 m) and five men (age: 20–51 years; weight: 74.8–118 kg; height: 1.73–1.85 m), from five different call-centres volunteered to the study. Bilateral trapezius surface electromyographic (sEMG) activity was recorded throughout the workday, and expressed with respect to a submaximal reference contraction. Perceived workload, positive and negative emotions, as well as the need for emotion control were recorded every 30 min on a 10-point scale. Periods of perceived high strain were compared to periods of low strain using paired comparisons.

### Results:

Despite generally low trapezius activity and overall low work demands, there was evidence of a small increase in trapezius activity and of a decrease in muscular resting time during high perceived workload periods. A workload difference equal or larger than two points on the rating scale resulted, on average, in 8 and 15% reduction in resting time for the non-dominant and dominant trapezius, respectively. However, there was no indication of sEMG alteration in relation with perceived positive or negative emotions, nor with emotion control.

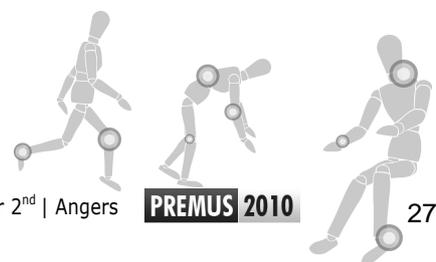
### Conclusion:

It is possible that a biomechanical component contributes to the altered trapezius activity during the high perceived workload periods. This will need to be addressed in future analyses. Furthermore, future analyses of communications could help identify specific periods with high emotional demands, which influence on trapezius activity could also be important.

**Keywords:** Muscle activity, Computer work, Psychosocial factors

### References:

Toulouse G, St-Arnaud L, Bourbonnais R, Delisle A, Chicoine D. Troubles musculo-squelettiques chez les téléopérateurs des centres d'urgence 911, des contraintes physiques aux contraintes psychosociales. PISTES 2009, 11 <http://www.pistes.uqam.ca/v11n2/articles/v11n2a7.htm>.



## DIFFERENTIAL EFFECTS OF PHYSICAL AND MENTAL TASKS ON CERVICAL MUSCLE ACTIVITY AND CARDIOVASCULAR RESPONSES

WANG Y.L., SZETO G.P.Y., CHAN C.C.

Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hong Kong SAR, China

### Aims:

The purpose of this laboratory study was to investigate the stress-induced responses in muscle activation and heart rate variability during acute physical and/or mental stress-induced tasks and recovery periods.

### Methods:

10 healthy young university students were recruited to perform 5 tasks with progressively increasing physical and/or mental demands which were manipulated using the Stroop color word test (CWT) based on a computer task program. Tasks 1-4 were of 5 min duration with 5 min rest in between while Task 5 was of longer duration (20 min). The tasks consisted of self-paced copy-typing, increased paced copy-typing, CWT, verbal CWT, and long duration CWT task. Surface electromyography (sEMG) data were collected bilaterally from cervical erector spinae (CES) and upper trapezii (UT) muscles. Simultaneous heart rate variability (HRV) data was recorded using the Polar RS800CX heart rate monitor (Polar Electro). Rate of perceived exertion (RPE) and anxiety assessment were asked at the start and end of each task.

### Results:

Compared with the self-paced copy-typing, muscle activations of bilateral UT and left CES were increased significantly during physical and mental tasks except verbal CWT (Table 1). There were an apparent increasing tendency of the low- to high-frequency ratio (LF/HF ratio), significant responses of rating of perceived exertion (RPE) and anxiety during the serial tasks. The results of rest periods showed that RPE and SBP have not recovered nearly to the baseline after long time CWT, similarly diastolic blood pressure still showed significantly higher values than baseline during rest 1, 2, and 4.

Table 1: EMG activity, cardiovascular and subjective measurements (Mean, SD) during different tasks and rest periods (n=10).

Recording condition/ variable	RPE	Anxiety	HRV (LF/HF ratio)	SBP (mmHg)	DBP (mmHg)	RCES ( $\mu$ V)	LCES ( $\mu$ V)	RUT ( $\mu$ V)	LUT ( $\mu$ V)
Baseline	7.1(1.1)	4.7(0.8)	0.98(0.86)	104.6(10.7)	69.9(6.4)	3.52(1.51)	6.82(2.66)	2.10(1.27)	1.46(1.28)
Self pace copy-typing	7.9(2.1)	4.4(0.8)	1.61(1.85)	106.6(11.4)	74.1(7.7)	3.63(1.45)	7.72(3.13)	2.57(1.47)	3.51(3.76)
Rest 1	7.3(1.6)	4.1(0.3)	0.92(0.78)	107.7(10.5)	73.5(6.2)#	2.95(1.20)	6.45(2.70)	1.88(1.72)	1.85(1.41)
Increased speed Copy-typing	8.8(2.0)*	5.4(1.2)*	1.43(0.90)	112.9(15.5)*	78.7(10.7)	5.01(4.09)	8.87(3.95)*	4.77(2.52)*	5.69(4.75)
Rest 2	7.6(1.5)	4.3(0.7)	1.61(1.84)	108.2(10.6)	75.8(6.7)#	3.38(2.00)	6.10(2.78)	2.79(4.57)	3.18(3.82)
CWT	9.0(2.3)*	6.2(1.5)**	1.45(1.22)	112.8(12.6)*	75.0(8.4)	5.05(4.13)	9.83(4.98)*	9.27(7.86)*	7.47(6.16)*
Rest 3	8.3(1.9)	4.0(0.0)	1.27(0.92)	107.2(9.2)	73.2(10.4)	3.56(2.98)	6.34(2.82)	2.92(5.87)	2.61(3.85)
Verbal CWT	8.9(2.2)	5.0(1.6)	1.49(1.12)	105.3(11.5)	74.3(8.4)	4.11(3.78)	7.11(3.32)	1.56(1.17)	3.08(3.47)
Rest 4	8.4(2.2)	4.3(0.7)	1.80(2.89)	108.0(7.8)	74.3(6.3)#	3.46(2.95)	6.16(3.36)	2.91(5.04)	1.87(1.91)
Long time CWT (20min)	11.0(2.9)**	6.3(2.4)*	1.56(1.09)	113.8(9.9)*	78.8(14.8)	5.04(3.50)	9.98(4.67)*	8.29(6.52)*	7.34(7.99)*
Rest 5 (10min)	8.9(2.5)#	4.1(0.3)	0.92(0.39)	111.0(12.1)#	73.0(4.3)	3.17(2.54)	5.80(2.95)	2.11(2.79)	1.89(2.21)

Note: each task compare to self pace copy-typing task. \* Significance level at  $P < 0.05$ , \*\* Significance level at  $P < 0.01$ . # shows the significance of rest periods compare to baseline.

RCES, right cervical erector spinae; LCES, left cervical erector spinae; RUT, right upper trapezii; LUT, left upper trapezii; SBP, systolic blood pressure; DBP, diastolic blood pressure.]

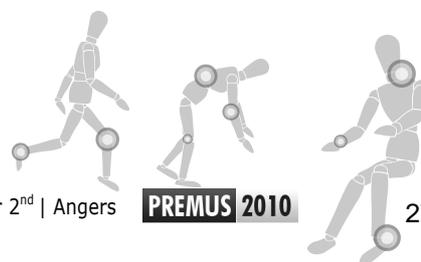
### Conclusion:

These findings suggest that healthy young individuals demonstrate apparent increases in muscle activity and cardiovascular response to certain physical or mental stressful workload of computer tasks.

**Keywords:** Muscle activity, psychosocial factors, neck

### References:

- Johnston V, J. G., Darnell R, et al. Alterations in cervical muscle activity in functional and stressful tasks in female office workers with neck pain. *Eur J Appl Physiol.* 2008; 103(3): 253-64.
- Garde AH, L. B., Jørgensen AH, et al. Effects of mental and physical demands on heart rate variability during computer work. *Eur J Appl Physiol.* 2002; 87(4-5): 456-61.
- Hjortskov N, R. D., Blangsted AK, et al. The effect of mental stress on heart rate variability and blood pressure during computer work. *Eur J Appl Physiol.* 2004; 92(1-2): 84-9.



## COMPUTER WORK AND MUSCULOSKELETAL DISORDERS OF THE NECK AND UPPER EXTREMITY: A SYSTEMATIC REVIEW

WAERSTED M., HANVOLD T.N., VEIERSTED K.B.

*National Institute of Occupational Health, Oslo, Norway*

### Aims:

This review examines the evidence for an association between computer work and neck and upper extremity disorders (except carpal tunnel syndrome).

### Methods:

A systematic critical review of studies of computer work and musculoskeletal disorders in the neck and upper extremity was performed. The disorders had to be verified by a physical examination. The search was performed in Medline, Embase, CisDoc and NIOSHTic2. Carpal tunnel syndrome was not included, as this condition was subject to a parallel review (Thomsen 2008).

### Results:

A total of 20 studies (25 articles) fulfilled the inclusion criteria. Thirteen studies were prospective, six were cross-sectional, and one study had a case-control design. However, due to few new cases during follow-up, several of the prospective studies mainly contributed with their baseline cross-sectional analysis. Results show limited evidence for a causal relationship between computer work per se, computer mouse and keyboard time related to a diagnosis of wrist tendonitis, and for an association between computer mouse time and forearm disorders. Limited evidence was also found for a causal relationship between computer work per se and computer mouse time related to tension neck syndrome, but the evidence for keyboard time was insufficient. Insufficient evidence was found for an association between other musculoskeletal diagnoses of the neck and upper extremities, including shoulder tendonitis and epicondylitis, and any aspect of computer work.

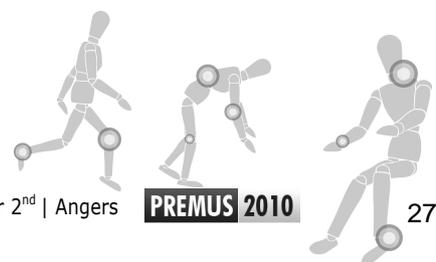
### Conclusion:

There is limited epidemiological evidence for an association between aspects of computer work and some of the clinical diagnoses studied, especially disorders of the forearm and hand. No evidence was considered as moderate or strong. There is a need for further studies on this topic. Probably should a case-control design be used more often, as this design is efficient with rare events.

**Keywords:** Computer work, Neck, Upper limb

### Reference:

Thomsen JF, Gerr F, Atroshi I. Carpal tunnel syndrome and the use of computer mouse and keyboard: a systematic review. *BMC Musculoskelet Disord.* 2008;9:134



**PERCEIVED MUSCULAR TENSION IS A RISK FACTOR FOR FUTURE NECK-SHOULDER SYMPTOMS**HUYSMANS M.A.<sup>1,2</sup>, BLATTER B.M.<sup>2,3</sup>, VAN DER BEEK A.J.<sup>1,2</sup><sup>1</sup> Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands - <sup>2</sup> Body@Work, Research Center on Physical Activity, Work and Health TNO-VU/VUmc, The Netherlands - <sup>3</sup> TNO Quality of Life, Hoofddorp, The Netherlands**Aims:**

The aim of the study was to investigate if perceived muscular tension is a risk factor for future neck-shoulder symptoms.

**Methods:**

Data were used from the PROMO study, a prospective cohort study among 1951 office workers with a follow-up duration of two years. Risk factors were assessed with a questionnaire at baseline and after one year of follow-up. Outcome was assessed every three months by means of a questionnaire. Neck-shoulder cases were identified based on the transition of 'no' or 'sometimes' pain to 'regular' or 'prolonged' pain. Following Wahlström et al. (2003) perceived muscular tension was asked as follows: "During the past three months, have you experienced muscular tension (e.g. wrinkled your forehead, grounded your teeth, raised your shoulders)?" Participants were classified into three groups: low tension ('never'), medium tension ('sometimes') and high tension ('several times per week' or 'one or several times per day').

Generalized Estimating Equations (STATA 10.0) were used to estimate Rate Ratios (RRs) for becoming a case. In order to ensure longitudinal analysis, exposure predicted outcome in future follow-ups. Subjects with symptoms at the time that perceived tension and other risk factors were assessed were excluded from the analyses for the following year.

**Results:**

Table Univariate and multivariate analyses of perceived muscular tension as a risk factor for neck-shoulder symptoms.

	Univariate N=1618 RR (95%CI)	Multivariate* N=1429 RR (95%CI)
Low tension	1	1
Medium tension	3.2 [2.2-4.8]	2.4 [1.5-3.7]
High tension	5.9 [3.9-8.8]	3.2 [2.0-5.1]

\*adjusted for confounders: gender, age, neck-shoulder symptoms in year before baseline, cognitive demands, reward, overcommitment, decision authority, task variation, repetition, shoulder flexion, manual materials handling at work. No effect modification was found.

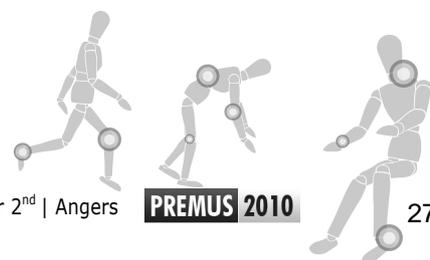
**Conclusion:**

Perceived muscular tension was a significant risk factor for future neck-shoulder symptoms, even when adjusted for important individual factors, psychosocial stressors and physical workload. Moreover, a dose-response relation was found. This is in line with Wahlström et al. (2003), who were the first, and to our knowledge the only ones, to report on perceived tension as a risk factor for neck pain. Results suggest that in order to prevent neck-shoulder symptoms, interventions could be aimed at lowering perceived muscular tension.

**Keywords:** Computer work, Personal risk factors for MSD, Pain, chronic pain

**References:**

Wahlström J, Hagberg M, Toomingas A, Wigaeus Tornqvist E. Perceived muscular tension, job strain, physical exposure, and associations with neck pain among VDU users; a prospective cohort study. *Occup Environ Med.* 2004;61:523-8.



## A COMPARISON OF EXPOSURE ASSESSMENT METHODS IN COMPUTER WORKERS

VAN EERD D.<sup>1,2</sup>, STEENSTRA I.<sup>1</sup>, KING T.<sup>1</sup>, SEVERIN C.<sup>1</sup>, COLE D.<sup>1,3</sup>, BIGELOW P.<sup>1,2</sup>, AMICK B.C.<sup>1</sup>, BEATON D.E.<sup>1,4</sup>

<sup>1</sup> Institute for Work & Health, Toronto, Canada - <sup>2</sup> Applied Health Sciences University of Waterloo, Waterloo, Canada - <sup>3</sup> Dalla Lana School of Public Health, University of Toronto, Toronto, Canada - <sup>4</sup> St Michael's Hospital, Toronto, Canada

### Aims:

Large-scale surveys show a one-year prevalence of upper extremity and neck symptoms vary from 24 to 44% among office workers. Computer use is considered a risk factor for musculoskeletal disorders in office workers(1); however, measuring computer use exposure is not consistently done(2). Our objective was to compare two non-intrusive and inexpensive methods of exposure assessment: self-report (SR) and electronic monitoring (EM). EM software is widely used; however it results in (systematic) underestimation in exposure time compared to self-report.

### Methods:

SR data was collected using web-based questionnaires for 15 consecutive days; workers were asked to report daily use of mouse, keyboard, and computer. EM software recorded computer, keyboard, and mouse use. A commercially available mouse with a built-in transducer ([www.hoverstop.com](http://www.hoverstop.com)) recorded the time the hand was on or directly over the mouse. Continuous monitoring of the position of the computer user's hand, relative to the mouse, gives a more accurate estimate of the time the user is in a potential straining or static posture. Pearson correlations were used to compare exposure durations for computer, keyboarding, and mouse tasks.

### Results:

26 computer workers agreed to participate and completed both SR and EM. However, there were SR and EM data missing if a subject was absent that day. SR data were also missing if a subject did not complete the questionnaire. EM data were missing due to computer software conflicts. The Pearson correlation between SR and EM for computer use was  $r=0.68$ , for keyboarding  $r=0.38$ , and mouse use  $r=0.54$ . The Pearson correlation between SR mouse and computer use was  $r=0.74$ , SR keyboard and computer use  $r=0.80$ , and SR mouse and keyboard use  $r=0.73$ . Whereas the Pearson correlation between EM mouse and computer use was  $r=0.95$ , EM keyboard and computer use  $r=0.66$ , and EM mouse and keyboard use  $r=0.40$ .

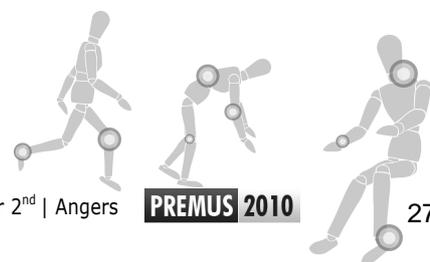
### Conclusion:

There are moderate correlations between SR and EM methods for mouse use and computer use, and a lower correlation for keyboard use. The relatively consistent high correlation between tasks in the SR method suggests that subjects are not able to differentiate between mouse, keyboard, and computer use. The high correlation between computer use and mouse use in the EM method suggests that computer user's hands are often in contact with the mouse. Self-report and activity monitoring may be measuring distinct constructs.

**Keywords:** Computer work, Exposure measurement methods, Upper limb.

### References:

Ijmker S, Huysmans MA, Blatter BM, van der Beek AJ, van Mechelen W, Bongers PM. Should office workers spend fewer hours at their computer? A systematic review of the literature. *Occup Environ Med* 2007; 64:211-222.  
Van Eerd D, Hogg-Johnson S, Mazumder A, Cole D, Wells R, and Moore A. Task exposures in an office environment: a comparison of methods. *Ergonomics*. 2009; 52(10):1248-1258.



## CONCURRENT VALIDITY OF THE SYMPTOM QUESTIONS OF THE INTERNET-BASED RSI QUICKSCAN IN COMPUTER WORKERS

SPEKLÉ E.M.<sup>1,2,3</sup>, HOOZEMANS M.J.M.<sup>1,3</sup>, VAN DIEËN J.H.<sup>1,3</sup>

<sup>1</sup> Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands – <sup>2</sup> Arbo Unie, Haarlem, The Netherlands – <sup>3</sup> Body@Work, Research Centre on Physical Activity, Work and Health, The Netherlands.

### Aims:

The proportion of people working with a computer has increased over the years and is still rising. Work-related arm, shoulder and neck symptoms occur frequently among computer workers. To assess the presence or absence of potential risk factors and arm, shoulder and neck symptoms in computer workers an internet-based questionnaire (RSI QuickScan) was developed (1). The objective of the present study was to determine the concurrent validity of the questions of the RSI QuickScan that concern the presence of arm, shoulder and neck symptoms.

### Methods:

160 employees of a Dutch occupational health service (Arbo Unie) were approached of which 106 decided to participate. Each of the employees was invited to see two occupational physicians. Just before seeing the first occupational physician the participants filled in the fourteen questions on arm, shoulder and neck symptoms in the RSI QuickScan, after which they were successively physically examined by both occupational physicians according to the guideline of the Netherlands Society of Occupational Medicine. The concurrent validity of the RSI QuickScan was determined by comparing the scores on the symptom questions concerning the presence of symptoms in the past 7 days to the observations of the two occupational physicians.

### Results:

Irrespective of body region, the proportions of observed agreement (PO) between the questionnaire and the two occupational physicians were 0.57 and 0.61 respectively. For the neck, shoulder and forearm/wrist/hand regions the PO ranged from 0.61 to 0.76. The highest values of PO were observed for the elbow (0.88-0.89). Kappa coefficients were low, and were between 0.16 and 0.53 with the highest values again observed for the elbow region. For the observed proportion of positive agreement (PPos), i.e. the agreement on the presence of symptoms, there were no large differences between the different body regions. Highest values of PPos were 0.61 and 0.68 for the presence of symptoms irrespective of body region for the two occupational physicians respectively. The observed proportion of negative agreement, i.e. the agreement on the absence of symptoms, showed the lowest values for the body regions taken together (0.51) and the highest values for the elbow region (0.93).

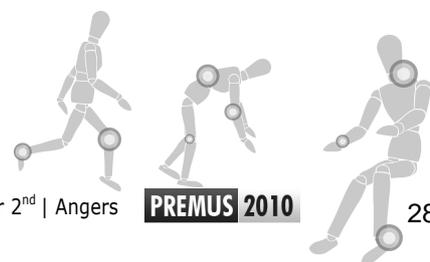
### Conclusion:

The concurrent validity of the symptom questions of the internet-based RSI QuickScan could overall be defined as moderate. Concurrent validity for detecting the presence of elbow symptoms and for detecting the absence of shoulder, elbow and forearm/wrist/hand symptoms can be considered sufficient.

**Keywords:** Computer work, Upper limb, Pain, chronic pain

### Reference:

Speklé EM, Hoozemans MJM, van der Beek AJ, Blatter BM, Bongers PM, van Dieën JH. Internal consistency, test-retest reliability and concurrent validity of a questionnaire on work-related exposure related to arm, shoulder and neck symptoms in computer workers. *Ergonomics*. 2009;52(9):1087-103.



## ACCOUNTING FOR INDIVIDUAL VARIABILITY IMPROVES ESTIMATES OF BIOMECHANICAL PARAMETERS IN COMPUTER WORKERS.

BRUNO J.L., HUYSMANS M.A., DENNERLEIN J.T.

*Harvard School of Public Health, Boston, MASSACHUSETTS, USA*

### **Aims:**

The goal of this study was to determine whether taking into account the natural variability within individual computer users (individual factors) can supplement information about the variability between that user's computer activities (task factors) and improve the accuracy of a model used to predict biomechanical parameters believed to be associated with musculoskeletal disorders.

### **Methods:**

In a laboratory experiment, continuous measurements of fifteen biomechanical parameters including shoulder and wrist postures, wrist dynamics, and muscle activity of seven upper extremity muscles were collected on each of 25 participants during five standardized computing activities that varied in amounts of keying and mousing. Mixed ANOVA models were used to determine the amount of variability explained by task factors (keyboarding, mousing, or idling) and individual factors (BMI, arm length, shoulder width, age) for the median biomechanical parameters. Terms that explained a significant amount of variability were used to create regression prediction models.

Based on this analysis, four possible categories of regression prediction models could be formed. A model could contain 1) both task and individual factors; 2) task factors but not individual factors; 3) individual factors but not task factors; or 4) neither task factors nor individual factors.

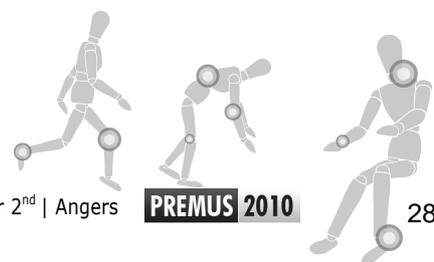
### **Results:**

Thirteen of the fifteen median biomechanical parameters examined could be estimated by either the first or third model categories. Individual factors were significant predictors in each of the thirteen models, and task factors were also significant predictors in five of the thirteen models. Zero parameters fit into the second model category, and the remaining two parameters fit into the fourth model category.

### **Conclusion:**

Based on these results, individual factors, as well as task factors, should be taken into account in order to predict biomechanical parameters during computer use. These estimates provide better exposure assessment of physical factors, without invasive direct measurements, which may allow researchers to understand which biomechanical parameters put computer users at risk for injury. Some things to consider in future studies should be to test these results using field instead of laboratory data, to include psychosocial factors as predictors in the models, since these things have also been shown to affect biomechanical parameters and musculoskeletal disorders.

**Keywords:** Postures, physical exposure, Computer work, Exposure measurement methods



## EFFECT OF SAMPLING STRATEGIES ON VARIANCE IN EXPOSURE INTENSITY METRICS OF TYPING FORCE AND WRIST POSTURAL DYNAMICS DURING COMPUTER WORK

ASUNDI K., JOHNSON P., DENNERLEIN J.T.

*Harvard School of Public Health, Boston, MASSACHUSETTS, USA*

### **Aims:**

The key component in choosing an appropriate sampling technique lies in the technique's ability to minimize variance across measures. In this study we aimed to evaluate variance in exposure intensity metrics calculated from measures collected across multiple days, multiple times of the day, different types of work and different locations during computer work.

### **Methods:**

Continuous measures of wrist extension, wrist ulnar deviation and typing force were collected at the workstation of 22 office workers while they completed their own work over three days for six hours per day. Data collected over the six hours each day were grouped into two hour intervals, representing three time-of-day episodes. Three times a day, participants were asked to complete a simulated 10 minute work task at their own workstation. Participants also completed the same simulated work task once in the laboratory at a simulated workstation adjusted to match their own. From the data, 26 exposure intensity metrics were calculated. For each wrist these included posture (10th 50th and 90th percentiles), range of motion, velocities and accelerations in both extension and ulnar deviation. For force, 50th and 90th percentiles were calculated. Linear mixed models were used to compare variance across subjects, day, time-of-day, type of work and location.

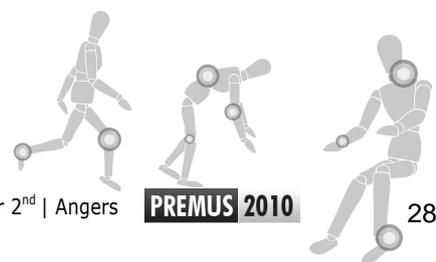
### **Results:**

For all exposure intensity metrics, variance across subjects was significantly greater than variance across days and time-of-day. Variance across subjects was greater than variance across type of work (actual vs. simulated) for 18 of the 26 exposure metrics. For 22 of the 26 metrics, variance across subjects was greater than variance across locations (field vs. laboratory). Type of work participants performed significantly affected several exposure metrics. Most exposure metrics for the wrist were unaffected by location, however typing forces were.

### **Conclusion:**

Our results indicate continuous measures of typing force and wrist postures collected over a two hour period were sufficient to identify differences in exposure intensity metrics between subjects. Furthermore, while simulated work significantly affects several exposure metrics, for most, differences across subjects were large enough to determine relative exposure between individuals. As typing force was affected by location and differences across subjects were not relatively large (50th and 90th percentile force were not among the 22 metrics with large across subjects variance), typing force measures collected in the laboratory cannot be used to determine relative typing force exposures.

**Keywords:** Postures, physical exposure, Computer work, Exposure measurement methods



## EFFECTS OF WORKSTATION CONFIGURATION ON TYPING FORCE, WRIST POSTURES AND WRIST DYNAMICS

ASUNDI K., JOHNSON P., DENNERLEIN J.T.

*Harvard School of Public Health, Boston, MASSACHUSETTS, USA*

### **Aims:**

Most practitioners and researchers recommend using a computer workstation where the keyboard height is set at or below elbow level as recommended by North American and European guidelines. However, in a related study, we noticed a number of participants set their keyboard support surface above elbow level with a positive tilt. Therefore, a study was conducted to evaluate the effect of this alternative workstation configuration on typing force, wrist postures and wrist dynamics.

### **Methods:**

Twenty office workers completed a standardized task at a workstation under two configurations, USER and STD. For the USER configuration chair height, seat pan depth, keyboard height (defined as the height from the floor to the “J” key), keyboard distance (defined as the distance of the “J” key to the edge of the support surface), keyboard tilt, monitor height and monitor distance were adjusted to emulate the participants’ actual workstation dimensions (measurements from the subjects actual workstation). For the STD configuration the same parameters were set up according to recommended guidelines based on North American Standards, with the “J” key roughly equal to the subject’s elbow height and the keyboard resting flat on the work surface with zero slope. Wrist posture (10th 50th and 90th percentiles and range of motion) and wrist dynamics (RMS velocities and RMS accelerations) were measured at 250Hz using bi-axial electrogoniometers. Typing forces were measured at 200 Hz with a force plate mounted under the keyboard.

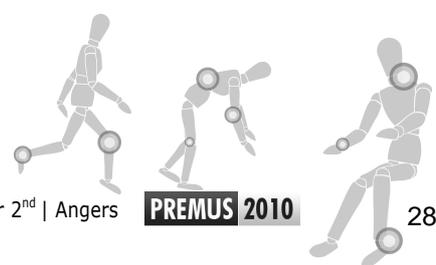
### **Results:**

On average, users set their working keyboard 7.2 cm higher than the height as recommended in the standards. All but 2 subjects tilted their keyboard with a positive slope (top row higher than bottom row) with an average slope of 12.5 degrees (5.2 deg std.dev.). No significant correlations ( $p>0.05$ ) between keyboard tilt and wrist postures, wrist dynamics or typing force were found. No significant differences were seen in mean typing force, wrist postures or wrist dynamics between the two configurations.

### **Conclusion:**

This study identified an alternative workstation configuration which leads to similar wrist postures, wrist dynamics and typing forces to those when users work in the STD configuration. The alternative workstation allows greater space under the keyboard support surface for leg clearance as well as improved visual access to the keyboard. Further studies should be conducted to evaluate the effects of this alternative configuration on muscle loads and additional upper extremity postures, particularly the shoulder.

**Keyword:** Biomechanics, postures, physical exposure, computer work.



## DIFFERENCES IN WRIST POSTURAL DYNAMICS ACROSS OFFICE WORKERS DURING COMPUTER AND NON-COMPUTER TASKS

ASUNDI K., JOHNSON P., DENNERLEIN J.T.

Harvard School of Public Health, Boston, MASSACHUSETTS, USA

### Aims:

For effective implementation of a task based exposure model, variance in exposure intensity measures across task must be significantly greater than the variance across subjects. In this study we aimed to compare postural dynamics of the wrist between computer tasks and non-computer tasks. We evaluated the effect of task on mean intensity measures as well as variance in measures across subjects and task.

### Methods:

Computer interaction monitoring software was installed on the computers of 20 office workers. From the software we identified periods of computer and non-computer tasks. Twin axis electrogoniometers collected continuous measures of wrist extension and ulnar deviation for 6 hours per day across 3 days as subjects completed actual office work. From the data, 10th 50th and 90th percentiles wrist postures, wrist range of motion and wrist dynamics (RMS velocities and accelerations) were then calculated for the computer and non-computer tasks. Repeated measures ANOVA was used to compare mean exposure intensity measures between the two tasks. F-ratios were calculated to compare variances in exposure intensity measures across tasks to variance in exposure intensity measures across subjects.

### Results:

Significant differences in exposure intensity measures were seen between computer and non-computer tasks (Figure 1). Significantly large F-ratios were found for 14 of the 18 outcome measures. Large variance in exposure intensity measures across task was seen primarily in range of motion, velocity and acceleration measures.

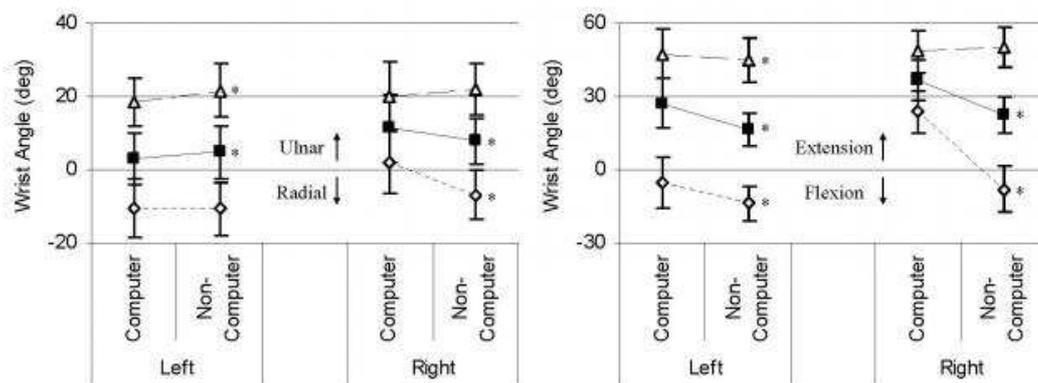


Figure 1. Mean (n=20) 10<sup>th</sup> (◇), 50<sup>th</sup> (■) and 90<sup>th</sup> (△) percentile ulnar/radial deviation and flexion/extension wrist angles. Error bars represent ±1SD. \* indicates a significant differences between tasks

### Conclusion:

Our findings from this group of office workers indicates that completing computer tasks leads to significant differences in biomechanical exposures of the wrist compared to non-computer tasks. Furthermore, for a number of these measures, the variability across tasks was significantly greater than the variability across subjects, indicating a task based exposure model may be a viable alternative to estimate exposure intensities for these wrist-based biomechanical risk factors.

**Keywords:** Biomechanics, computer work, exposure measurement methods



## ASSOCIATIONS BETWEEN DISCOMFORT AND DISCREPANCIES IN ANTHROPOMETRICS AND WORKSTATION SETUP

BAKER N.A., MOEHLING K., XIU K.H.

Department of Occupational Therapy, University of Pittsburgh, Pittsburgh, Pennsylvania, USA

### Aims:

This study examined the associations between discomfort levels and discrepancies between subjects' workstation configurations and their anthropometrics. We hypothesized that higher discomfort levels are associated with greater discrepancies.

### Methods:

Workstation configuration and anthropometrics were measured for 60 staff and faculty at the University of Pittsburgh with musculoskeletal discomfort  $\geq 2$  on a 10-point scale. Discomfort levels were obtained using a VAS scale for the eye, neck/shoulder, back, right and left arm/hand. Levels were categorized into a six level discomfort scale.

Discrepancies between workstation configurations and anthropometrics were translated to risk levels: seat depth to buttock-popliteal length; chair height to floor-popliteal height; keyboard height to seated elbow height; and monitor height to seated eye height. Three risk levels (1) acceptable discrepancies, 2) minimal discrepancies and 3) unacceptable discrepancies) were defined for each risk.

We used Spearman's correlations to compare reported discomfort with risk levels.

### Results:

Subjects were primarily female (N=55), 44.2 ( $\pm 12.2$ ) years, and spent between 6-10 hours/day on the computer. Significant associations were found between neck/shoulder, back discomfort and the seat depth, also between the right arm/hand discomfort and the keyboard height (Table 1).

		Seat depth (M 1.1 $\pm$ 0.3)	Seat hght (M 1.2 $\pm$ 0.4)	Keyboard hght (M 2.2 $\pm$ 0.9)	Monitor hght (M 2.2 $\pm$ 0.9)
		<i>r</i>	<i>r</i>	<i>r</i>	<i>r</i>
Eye	(M 1.0 $\pm$ 0.9)	.06	-.03	.02	.08
Neck/Shld	(M 1.6 $\pm$ 1.2)	<b>.30*</b>	-.12	.22	-.03
Back	(M 1.5 $\pm$ 1.1)	<b>.30*</b>	-.05	.05	.02
R arm/hand	(M 1.5 $\pm$ 1.2)	.12	.05	<b>.28*</b>	.01
L arm/hand	(M 0.9 $\pm$ 0.9)	.16	.03	.05	.02

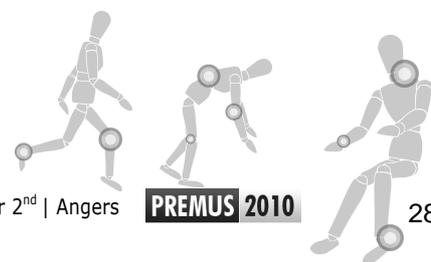
\* $p < .05$

### Conclusion:

Higher levels of reported discomfort for neck/shoulder and back were associated with higher risk levels for the seat depth, indicating that the general seat depth may be too long for workers to rest their back against their back rests. Higher levels of reported discomfort for right arm/hand were associated with greater risk levels for keyboard height, suggesting that the keyboard was either too low or too high for workers. These associations highlight the importance of adjusting the workstation to match individual's anthropometrics to reduce MSD in the workplace.

Acknowledgements: Funding was provided by the National Institute of Occupational Safety and Health 5R01OH008961-02.

**Keywords:** Mechanism of pain and tissue injury, computer work, personal risk factors for MSD



## TIME DISTRIBUTION OF TRANSVERSE METACARPAL ARCH DURING COMPUTER KEYBOARD TYPING

BAKER N.A.<sup>1</sup>, XIU K.H.<sup>1</sup>, MOEHLING K.<sup>1</sup>, LI Z.M.<sup>2</sup>

<sup>1</sup> Department of Occupational Therapy, University of Pittsburgh, Pittsburgh, Pennsylvania, USA – <sup>2</sup> Departments of Biomedical Engineering, Physical Medicine and Rehabilitation, and Orthopaedic Surgery, Cleveland Clinic, Cleveland, Ohio, USA

### Aims:

The transverse metacarpal arch (TMA), formed at the distal metacarpal heads, modulates during finger motion. This study investigated the time distribution of the TMA during typing.

### Methods:

30 subjects' (42.1±12.8 yrs) bilateral hand postures of 5s static "neutral" position and 60s dynamic typing were collected using the VICON™ system. The TMA for each sampling frame was calculated as the acute angle between radial (formed by markers on the proximal 3rd metacarpal, 2nd and 3rd MCP) and ulnar planes (formed by markers on the proximal 3rd metacarpal, 3rd and 5th MCP).

To calculate the TMA time distribution, we examined the time subjects spent with TMAs flatter or more curved than their neutral posture for one degree increments. We used paired t-test to investigate TMA time distributions between the left and right hand ( $\alpha=0.05$ ).

### Results:

During the dynamic typing, the flatter TMA (Left/Right) time decreased consistently from 20.5±23.1s/25.7±23.6s at 1° flatter to 3.6±10.9s/6.5±14.9s at 7° flatter. The more curved TMA (Left/Right) time decreased consistently from 30.6±22.2s/23.2±22.0s at 1° more curved to 5.3±11.2s/4.7±12.9s at 7° more curved (Table 1).

Table 1. The time distribution of the TMA at each flatter and more curved postures

	Flatter (unit: s)		More curved (unit: s)	
	Left	Right	Left	Right
1°	20.5±23.1	25.7±23.6	30.6±22.2	23.2±22.0
2°	17.2±22.7	20.7±22.7	25.3±21.2	17.3±19.8
3°	14.0±20.8	16.6±21.5	19.5±19.4	12.2±18.1
4°	11.0±18.2	13.2±20.2	14.6±18.1	9.1±17.2
5°	7.7±15.3	10.4±18.7	10.8±16.9	7.2±16.2
6°	5.2±12.9	8.2±17.1	7.8±14.8	5.8±14.8
7°	3.6±10.9	6.5±14.9	5.3±11.2	4.7±12.9

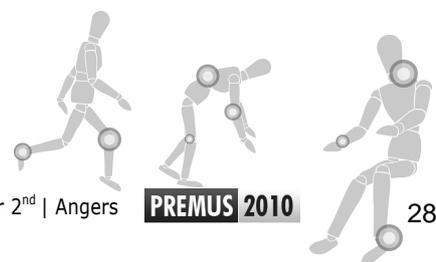
There were no significant differences between the left and right hands for TMA time distributions.

### Conclusion:

Although the results indicated no significant differences, there is a consistent trend that the right hand spent more time in flatter postures and the left hand more time in more curved postures. This could relate to the different tasks undertaken by the left and right hand. The right hand flattens more often to reach the backspace/shift/enter keys during typing. Maintaining extremely flat and/or curved TMA postures may place the hands at risk for the musculoskeletal discomfort (MSD). Further research is needed to examine and understand the role of the TMA in typing and its association with MSD.

ACKNOWLEDGEMENT: Funding was provided by NIOSH 5R01OH008961-02.

**Keywords:** Biomechanics, Computer work, Upper limb.



## CAN ACCELEROMETER MEASUREMENTS OF THE HEAD DIFFERENTIATE BETWEEN TWO VISUALLY SIMILAR COMPUTER WORK TASKS?

BERNMARK E., FORSMAN M., WIKTORIN C.

*Division of Occupational and Environmental Medicine, Department of Public Health Sciences, Karolinska Institutet, Stockholm, Sweden*

### **Aims:**

The data used in this paper were collected at a company where the occupational health service had found that a certain new computer work task caused more discomfort and pain from the neck region among the workers than the traditional computer work tasks. The discomfort and pain reported by the workers when performing this new task could be due to a higher degree of static work for the head, i.e. lack of head movements when performing this specific task compared to traditional computer tasks. Possibly, a triaxial or even a uniaxial accelerometer could be used for detecting if the head movements differed when performing this new specific computer work task in relation to the traditional computer work tasks.

The purposes of the present study were (1) to investigate if potential differences in head inclinations and accelerations during two similar computers work tasks, could be detected using a triaxial accelerometer, and (2) to investigate if potential differences in head accelerations during two different computer work tasks could be detected using a uniaxial accelerometer.

### **Methods:**

Ten subjects' head movements were registered with a triaxial accelerometer system during two different document management tasks at the work place: 1) Electronic document management 2) Traditional document management. The electronic document management task was experienced as more static for the head among the users.

The accelerometer system consisted of four triaxial accelerometer sensors and a data logger (1). A triaxial accelerometer measures the accelerations in three directions. A uniaxial accelerometer was simulated by analyzing the acceleration in the vertical direction.

### **Results:**

The triaxial accelerometer registrations showed a significantly wider range of forward-backward head inclinations between the 5th and 95th percentiles when working with traditional document management than when working with electronic document management. Both the triaxial and the simulated uniaxial accelerometer registrations showed a significantly higher median acceleration of head when working with traditional document management than when working with electronic document management.

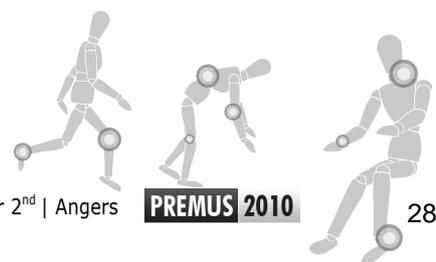
### **Conclusion:**

The conclusion is that for the head, and at least for work similar to this office work, potential dynamic differences in work tasks, that are visually similar, can be investigated by using a triaxial accelerometer. If only acceleration is focused, also a uniaxial accelerometer can be used.

**Keywords:** Postures, physical exposure Computer work Exposure measurement methods

### **Reference:**

Hansson, G.-Å., Asterland, P., Holmer, N. G., Skerfving, S., 2001. Validity and reliability of triaxial accelerometers for inclinometry in posture analysis. *Med Biol Eng Comput.* 39(4), 405-13.



## A VIDEO-BASED POSTURAL ASSESSMENT SYSTEM TO MEASURE ROTATION OF THE SHOULDER DURING COMPUTER USE

BRUNO J.L., LI Z., TRUDEAU M., RAINA S., DENNERLEIN J.T.

Harvard School of Public Health, Boston, USA

### Aims:

The goals of this study were to describe a video-based postural analysis system which can be used for field measurements of computer users, to evaluate the consistency of the video system compared to a three dimensional motion analysis system, and to quantify the limitations of the video system.

### Methods:

The video-based system is designed to measure shoulder rotation, a suspected risk factor for upper extremity musculoskeletal disorders. [Dennerlein 2006, Karlqvist 1998] The proposed system consists of a commercially-available digital video camera, simple black and white paper markers, custom marker-tracking software, and custom angle calculation software. To evaluate the video system, shoulder rotation was measured using both a video-based system and a three-dimensional motion analysis system during a laboratory test. To measure a range of postures, participants moved both hands to different locations during a forced-abduction trial and a simulated computer mousing trial. Simple linear regressions were used to determine correlations between angles calculated using the video system and the three-dimensional angles, with corresponding slopes and intercepts. T-tests and 95% confidence intervals were used to compare the results of the computer mousing trial to the forced-abduction trial.

### Results:

The average correlations, slopes, and intercepts for both hands were significantly better for the computer mousing trial than the forced-abduction trial. For the computer mousing trial, the average correlation between the video and three-dimensional motion analysis systems for the right hand was 0.94 [0.88, 1], and for the left hand was 0.90 [0.79, 1]. The confidence intervals for the slopes and intercepts for this trial contained 1 and 0, respectively. There was a significantly smaller range of motion for shoulder abduction during the computer mousing trial (22.31 degrees) than during the forced-abduction trial (35.65 degrees).

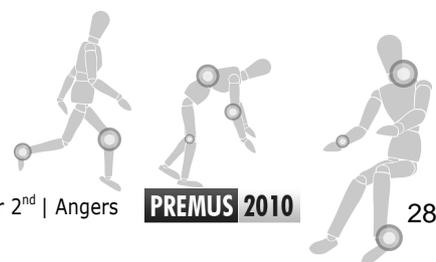
### Conclusion:

The video-based system is comparable to three-dimensional systems for measuring shoulder rotation in computer workers. This system performs best when calculating rotation during natural computer work, with limited shoulder abduction.

**Keywords:** Postures, Physical exposure, Computer work, Exposure measurement methods

### References:

- Dennerlein JT, Johnson PW. Different computer tasks affect the exposure of the upper extremity to biomechanical risk factors. *Ergonomics*. 2006;49(1):45-61.
- Karlqvist LK, Bernmark E, Ekenvall L, Hagberg M, Isaksson A, Rostö T. Computer mouse position as a determinant of posture, muscular load and perceived exertion. *Scand J Work Environ Health*. 1998;24(1):62-73.



## A COMPARISON OF WRIST ROM AND THE PREVALENCE OF WRIST ABNORMALITIES IDENTIFIED WITH MRI BETWEEN SYMPTOMATIC AND ASYMPTOMATIC COMPUTER USERS

BURGESS R.A., PAVLOSKY W.F., THOMPSON R.T.

Lawson Health Research Institute, London, On, Canada

### Aims:

Previous work has shown an association between restricted wrist range of motion (ROM) and upper extremity musculoskeletal disorders associated with computer use (1). We compared wrist ROM and the prevalence of MRI identified wrist abnormalities between symptomatic and asymptomatic computer users.

### Methods:

Electrogoniometric measures of maximum active wrist flexion and radioulnar deviation, and MR images at 1.5 T of both wrists were obtained from 12 computer users (10 F, 2 M; mean age = 39 yrs.) with chronic wrist pain (10 bilateral; 2 right), and 10 age and gender matched asymptomatic controls.

### Results:

Intraosseous “fluid-like” lesions located adjacent to ligament attachment sites were identified from the MR images of 12/22 asymptomatic wrists (25 lesions) and 16/22 symptomatic wrists (30 lesions). The dominant and non-dominant wrists were affected equally, and the majority of the lesions were within the capitate and lunate in both the asymptomatic (60%) and symptomatic (60%) wrists. The mean maximum area of the intraosseous lesions in the symptomatic wrists ( $10.2 \pm 10.7 \text{ mm}^2$ ) was not significantly different from the asymptomatic wrists ( $6.1 \pm 3.2 \text{ mm}^2$ ),  $p = .09$ .

Twenty-one extraosseous ganglia (EOG) were identified in 13 asymptomatic wrists (9 R), and 21 EOG were identified in 16 symptomatic wrists (14 R). The most frequent site was adjacent to the pisotriquetral joint (5/21) in the asymptomatic group, and volar to the radioscaphoid joint (9/22) in the symptomatic groups. There was no significant difference in the mean maximum area of EOG between the asymptomatic ( $29 \pm 18 \text{ mm}^2$ ) and symptomatic wrists ( $31 \pm 30 \text{ mm}^2$ ),  $p = .80$ .

Extensor tenosynovitis was identified in 2 asymptomatic and 5 symptomatic wrists. Distal ECU tendon subluxation was identified in 14 asymptomatic wrists and 14 symptomatic wrists. A persistent median artery was identified in three symptomatic wrists. Asymptomatic right wrist flexion ( $69.7 \pm 7.4 \text{ deg.}$ ) was significantly greater than symptomatic right wrist flexion ( $60.7, \pm 7.3 \text{ deg.}$ ),  $p = .01$ .

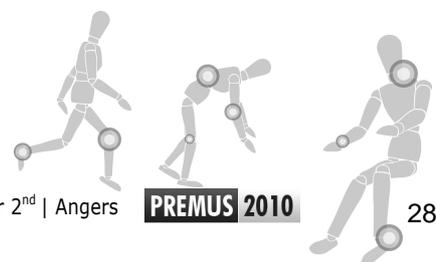
### Conclusion:

Except for 3 cases of a persistent median artery, there was no difference in the prevalence of MRI identified abnormalities between asymptomatic and symptomatic wrists. Intraosseous lesions suggestive of intraosseous ganglia (2) tended to be larger in the symptomatic wrists, but this was not significant. Right wrist flexion was restricted in the symptomatic group, which may be due to pain avoidance or may indicate reduced extensibility of the extensor musculature. The overall prevalence (64%) of ECU subluxation is unusual.

**Keywords:** Computer work, Upper limb, Pain, Chronic pain

### References:

- Pascarelli EF, Kella JJ: Soft-tissue injuries related to use of the computer keyboard. A clinical study of 53 severely injured persons. *J Occup Med* 1993, 35: 522-532.
- Schrank C, Meirer R, Stabler A, Nerlich A, Reiser M, Putz R: Morphology and topography of intraosseous ganglion cysts in the carpus: an anatomic, histopathologic, and magnetic resonance imaging correlation study. *J Hand Surg [Am]* 2003, 28: 52-61.



## A SURVEY OF COMPUTER USAGE AND ERGONOMIC PRACTICES AMONG FACULTY AT A UNIVERSITY WITH A MANDATORY MOBILE PC PROGRAM

COOPER K.<sup>1</sup>, CAMPBELL-KYUREGHYAN N.<sup>1,2</sup>, SOMMERICH C.<sup>3</sup>

<sup>1</sup> University of Wisconsin – Milwaukee, Dept. of Industrial and Manufacturing Engineering, Milwaukee, WI USA – <sup>2</sup> University of Wisconsin – Milwaukee, Center for Ergonomics, Milwaukee, WI USA – <sup>3</sup> The Ohio State University, Dept. of Integrated Systems Engineering, Columbus, OH USA

### Aims:

Universities world-wide are increasingly implementing mandatory mobile PC (laptop or tablet) programs for students and faculty. The aim of this study was to evaluate the computer ergonomics needs for university faculty in a mandatory mobile PC environment.

### Methods:

An online questionnaire was administered to the faculty at an engineering college in the United States with a mandatory mobile PC program. The questionnaire inquired about the duration and frequency of their computer use along with their posture during use and any associated discomfort. The participant responses were divided by the computer type (Tablet PC, Laptop/Notebook PC or Desktop PC) used most often.

The responses were analyzed regarding the duration of continuous computing, awkward postures, and pain or discomfort associated with computer usage. The PCSit Score and PCPain (Sommerich 2002) were calculated based on the responses. PCSit Score is a composite score of the duration of continuous computing without a rest period and PCPain is the number of body areas in which the participant indicates that they experience discomfort

### Results:

50 faculty completed an online questionnaire (73% response rate, 78% completion rate). Nearly all faculty (70%) indicated using multiple computer configurations daily. However, they indicated a main computer of a Tablet PC or Laptop/ Notebook PC (32%), Desktop PC (66%) or none (2%). On a scale of 1-5, most respondents (86%) indicated no (1) or low knowledge (2-3) of safe computing work practices. 35% of faculty reported pain in at least one body area Almost Always or Quite Often during or immediately after using a computer.

The PCSit Score for mobile PC users (3.25+/-1.2) was significantly ( $p<0.03$ ) higher than for Desktop PC (2.56+/-1.1) users, indicating that Mobile PC users are more likely to compute continuously. While computing, faculty (Mobile-73%, Desktop PC-79%) reported assuming awkward postures at least Sometimes. The Pearson correlation revealed a strong (.74,  $p<.001$ ) relationship between PCSit Score and PCPain for Mobile PC users. No statistically significant relationship existed for Desktop PC users (.28  $p=.15$ ).

### Conclusion:

Faculty in this study reported not having knowledge of safe computing practices, reflected in their reports of continuous computing (lack of breaks) and assuming awkward postures. Combined with their reports of pain and discomfort associated with computer usage, a clear first step is evident. Ergonomic awareness training should be incorporated into the university environment. As universities increasingly implement mandatory computer programs, in an effort to produce technically savvy graduates, the need for such training will continue to grow.

**Keywords:** Computer work, exposure measurement methods, pain, chronic pain

### Reference:

Sommerich CM. A survey of desktop and notebook computer use by professionals. Proceedings of The Human Factors and Ergonomics Society 46th Annual Meeting, Baltimore, MD: 2002.



## PLACE OF MUSCULOSKELETAL DISORDERS IN LAPTOP USE AND THEIR PREVENTION WITH STRETCH BREAK EXERCISES.

DEPARIS P.<sup>1</sup>, FAUCHEUX D.<sup>2</sup>, PETITPAS C.<sup>2</sup>

<sup>1</sup> Company IBM France, Health Services, Bois-Colombes, France - <sup>2</sup> IBM France, Medical Unit, Noisy-le-Grand, France.

### Aims:

Musculoskeletal disorders represent a large proportion of occupational injuries within which computer use is likely to be responsible for. At IBM, despite available ergonomic solutions, some musculoskeletal-like symptoms concomitant to laptop-based working conditions have been identified. We report their features and interest of active pauses in their prevention such as stretch break exercises, knowing that the specific consequences from laptop use have been few documented and that active pauses in comparison with passive pauses commonly recommended remain poorly developed.

### Methods:

Based on a structured questionnaire to every legally required medical exam during a 9 months period and on a stretch break self-exercises education program in parallel, we explored: any individual painful complaint and its localisation, each postural conditions and each feed-back from well-installed people included in the program due to past related symptoms.

### Results:

In a sample of 274 employees (26% of our usual population) using intensively a laptop computer, 16% mentioned algetic signs in osteoarticular sphere, equally distributed between back and upper limbs. Among them, a wide majority has declared to be correctly equipped and positioned when working. One of ten has benefited from our 'pause active' program, mostly successfully.

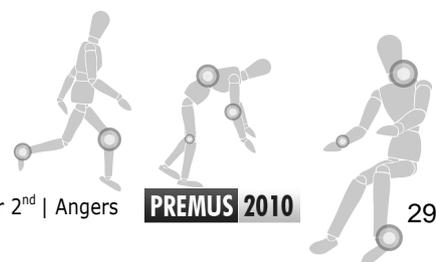
Our findings seem generalizable to other staff given the similarity in direct working environments and computer use.

### Conclusion:

This survey shows the laptop use impact on musculoskeletal system, often established by analogy with the effects coming from desktops. Moreover, it highlights the importance to systematize the ergonomic evaluation which is specific in that situation and to enlarge preventive measures through the stretch break exercises concept.

Laptop-related musculoskeletal disorders exist. Active pauses in the form of stretch break self-exercises are likely to be helpful. In such environment, other causal factors should also be investigated more in-depth, ergonomic solutions being not enough to prevent them totally.

**Keywords:** Postures, physical exposure, Computer work, Intervention methods.



## MUSCULOSKELETAL SYMPTOMS IN CHILDREN USING COMPUTERS AT HOME - A PROPOSED MODEL

HARRIS C., STRAKER L., SMITH A., POLLOCK C.

*Curtin University of Technology, Australia*

### **Aims:**

The etiology of musculoskeletal symptoms (MSS) associated with the use of information technology (IT) has predominately been defined by studies of adults in their work environments. Theories explaining the causation of work related musculoskeletal disorders have identified individual (biomechanical, physiological and psychosocial), task demand, work organization and environmental risk factors. Models based on these theories have subsequently been developed to investigate the causal relationship between IT exposure and MSS experienced by the user.

As IT use by children is rapidly growing in both home and school environments, current literature demonstrates an increase in MSS related to children's IT use. Children's use of IT appears to be very different to adult's use of IT in work environments.

Although many potential risk factors may be similar, due to the nature of children and their different occupational roles and environments, it is proposed that risk factors and models of causal relationships between computer use and MSS would vary for children.

The aim of this study was therefore to develop a model that would assist in understanding the causation of MSS in children using computers at home.

### **Methods:**

1351 children in school Years 1, 6, 9 and 11 (ages ~ 6,11,14,16, years) from 10 schools in metropolitan Western Australia were surveyed. Descriptive statistics were used to describe the sample, and Spearman rank correlation coefficients (rs) and logistical regression analysis were used to examine direction and relationships of independent and dependent variables. MPlus statistical modelling program version 5 was used to estimate the proposed relationships between variables, with dependent variables of home computer exposure and symptoms.

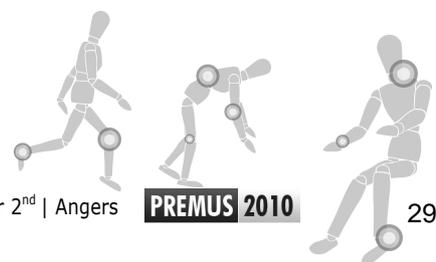
### **Results:**

Risk factors found to have a significant direct effect on participant's reports of MSS included; gender, age, somatic complaints (headache and stomach ache) and computer exposure. Risk factors found to have a direct effect on computer exposure (and indirect effect on MSS) included age, television exposure, computer anxiety, sustained attention (flow), socio-economic status, somatic complaints (headache).

### **Conclusion:**

The proposed child-specific model will assist academics, teachers and parents to understand the risk factors for MSS associated with children's home computer use, and therefore assist in targeting interventions that would encourage the use of this valuable technology in a safe and productive manner.

**Keywords:** Mechanism of pain and tissue injury, Computer work, Personal risk factors for MSD



## MUSCULOSKELETAL AND VISUAL DISCOMFORT AMONG MIDDLE SCHOOL NOTEBOOK COMPUTER USERS

JACOBS K., KALDENBERG J., MARKOWITZ J., WUEST E., HELLMAN M., LELAND-WIATROWSKI N., ARSENAULT M., WALKER B., HALL V.

*Boston University, USA*

### **Aims:**

This longitudinal study investigates how middle students use notebook computers. The study was initiated in January, 2009, where 34 7th grade students participate yearly for six years through 12th grade. Knowledge of ergonomics, vision, anthropometric measurements, typing ability, musculoskeletal discomfort, activity participation, use of notebook accessories in the home and the impact of participatory ergonomic training reinforced through web based education is investigated.

### **Methods:**

A repeated measures study design was used. Twice yearly during the academic year, all participants complete an online quiz about ergonomics, online typing test, and the online version of the Young People's Activity Questionnaire (YAQ). The on-line surveys are completed on the study's website at: [www.ergonomicsfortherapists.com](http://www.ergonomicsfortherapists.com) Yearly anthropometric measurements are taken and participants receive an eye examination from a vision specialist. Computer monitoring software has been installed on all participants' notebook computers. This software records exposure level factors, such as usage, and breaks. At the start of the study, all participants received participatory ergonomics training, a notebook riser, mouse pad with tips for arranging a notebook computer workstation, and a digital camera. Photographs of participants' working at their home computer workstation in non-poised postures are emailed to the primary researcher. Participants were randomly assigned to one of two conditions: condition #1 received a wireless keyboard and wireless mouse for use at home while condition # 2 received a wireless split keyboard and wireless mouse.

### **Results:**

Thirty-four students (56% males; 44% females) agreed to participate in the study with an average age of 12.4 years. The notebook computer monitoring software found an average computing time of 1.99 hours per day. All Participants (n=34) experienced one or more vision symptoms. Pearson's R correlation showed a positive correlation between the number of symptoms and typing speed. As typing speed increased so did the number of symptoms reported. Neck and shoulder pain, dry watery eyes, sore tired eyes, and back pain were the symptoms reported most frequently. Fifty-six percent of participants reported neck and shoulder pain while at computer and watching TV ( $p < 0.0$ ).

### **Conclusion:**

This study identifies that not only musculoskeletal discomfort is present in school aged students, but that they are experiencing vision symptoms associated with notebook computer use. This longitudinal study will continue to provide education about computer ergonomics and will monitor its impact through 12th grade.

**Keywords:** Exposure measurement methods, Early prevention, Intervention studies

### **References:**

- Jacobs, K., Hudak, S., McGiffert, J. (2008). Computer-related posture and musculoskeletal discomfort in middle school students. *Work: A Journal of Prevention, Assessment, and Rehabilitation*, 32, 275-283.
- Kelly, G., Dockrell, S., & Galvin, R. (2008). Computer use in school: Its effect on posture and discomfort in school children. *Work: A Journal of Prevention, Assessment & Rehabilitation*, 32, 321-328.
- Harris, C., Straker, L., Pollock, C., Trinidad, S. (2005). Musculoskeletal outcomes in children using information technology- the need for a specific etiological model. *The International Journal of Industrial Ergonomics*, 35, 131-138.



## HEALTH AND PERFORMANCE BENEFITS FOR CHILDREN WHEN USING CHILD-PROPORTIONAL MICE AND KEYBOARDS

JOHNSON P.W., CUI L.

*Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, WA, USA*

### **Aims:**

Studies have shown that children can experience musculoskeletal discomfort or develop musculoskeletal disorders when using computers. Unlike adults, children have smaller anthropometric dimensions and a developing musculoskeletal system, both of which may predispose them to musculoskeletal problems at a young age. The aim of this study was to investigate whether there were any health and performance effects when children used child-proportional rather than standard, adult-sized mice and keyboards.

### **Methods:**

A total of 42 subjects, including 28 adults and 14 children between the ages 6-8 participated in the study. Subjects were asked to perform a series of standardized point-and-click tasks using a standard adult-sized mouse and a medium and small child-sized mouse. In addition, subjects operated the mouse next to a keyboard with and without a numeric keypad. During mouse use, movement times, mouse button click durations and wrist postures were measured. When operating the mouse next to the keyboard with and without the numeric keypad, shoulder abduction and shoulder rotation were measured from overhead photographs.

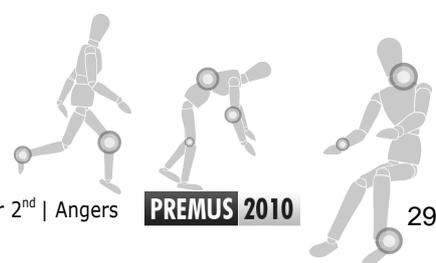
### **Results:**

Relative to the standard adult-sized mouse, children had significantly faster movement times ( $p < 0.05$ ) and significantly less ulnar deviation ( $p < 0.05$ ) with the small and medium sized mice. For the adults, there were no performance or wrist postural differences between the three mice. On average, when compared to the adults, it took children twice as long to activate the mouse button. Both children and adults took significantly longer ( $p < 0.05$ ) to activate the buttons on the smaller mice. When operating the mouse next to the keyboards with and without the numeric keypad, both children and adults had significantly less shoulder abduction ( $p < 0.05$ ) and external rotation ( $p < 0.05$ ) when using the keyboard without the numeric keypad.

### **Conclusion:**

Children would benefit from both a postural and performance standpoint if computer manufacturers sold, and schools and parents purchased, computers with child-proportional mice and keyboards. Based on the time differences between children and adults to activate the mouse button, children would likely benefit from mice with lower button activation forces.

**Keywords:** Postures, Physical exposure, Computer work, Personal risk factors for MSD



## CHANGE OF INTERKEYPRESS INTERVALS DURING 90-MINUTE CHINESE TYPING WITH TWO INPUT METHODS

LIANG H.W., HWANG Y.H.

Department of Physical Medicine and Rehabilitation, National Taiwan University Hospital and National Taiwan University College of Medicine, Taipei, Taiwan, ROC.

### Aims:

Boshiamy, one of the popular input methods for traditional Chinese, is proved a more efficient typing tool than Microsoft New Phonetic method. However, whether such fast finger motions attribute high risk of fatigue or musculoskeletal disorders is not studied yet. We observed a continuous Chinese typing for 90 minutes with these two input methods. Our aim is to explore typing performance by analyzing the change of interkeystroke intervals.

### Methods:

Sixteen subjects typed a Chinese text for 90 minutes by using either Microsoft New Phonetic or Boshiamy according to their preference. All keystrokes and their interkey press intervals (IKI) were recorded by electronic activity monitoring software, VDTlog. The keystrokes were grouped as same finger, same hand or different hands according to the finger used to press prior keys. The 10th, 50th and 90th percentiles of IKIs were calculated for the first and last 5-minute period of 90-minute typing and the data was compared for each group by Wilcoxon sign rank test.

### Results:

The subjects who used Boshiamy typed significantly more characters than those who used Microsoft New Phonetic (7,370 vs. 8,421 characters,  $p=0.02$ ). All the parameters of the first and the last 5-minute data were not different in Microsoft New Phonetic group. In contrast, the 50th percentile and 90th percentile of different-hand IKIs increased significantly for Boshiamy group.

Table. The 10th, 50th and 90th percentile of interkeypress intervals (IKIs) at the first and last 5-minute typing for two input methods of Chinese

	Microsoft New Phonetic (n=9)		Boshiamy (n=7)	
	0-5 minute	85-90 minute	0-5 minute	85-90 minute
IKIs by the same finger (ms)				
10th percentile	146.8±55.3	136.2±62.1	117.0±50.1	116.2±64.2
50th percentile	267.6±27.0	245.2±26.4	169.6±19.0	178.1±21.6
90th percentile	547.8±109.6	463.4±71.8	218.6±42.0	225.0±42.6
IKIs by the same hand (ms)				
10th percentile	56.7±18.5	58.1±17.7	62.1±26.6	63.9±21.7
50th percentile	182.9±28.5	211.9±29.6	119.1±41.0	127.4±42.5
90th percentile	514.3±73.7	462.5±73.9	202.9±50.1	214.0±49.1
IKIs by different hands (ms)				
10th percentile	44.0±21.2	50.0±22.5	57.4±16.1	60.1±10.6
50th percentile	112.1±18.7	109.4±19.9	97.6±15.9	107.8±13.3*
90th percentile	389.9±68.9	373.0±57.5	160.4±27.1	192.1±31.1*

\* $p<0.05$  by comparing with the first 5-minute data

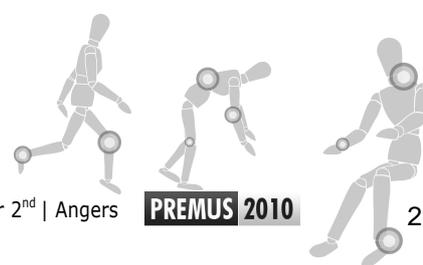
### Conclusion:

In comparison with Microsoft New Phonetic group, Boshiamy group typed more characters during 90-minute typing and also demonstrated a significant prolongation of 50th and 90th percentile of different-hand IKIs. These findings are not supportive of prior hypothesis that the same-finger IKI might serve as an indicator of motor fatigue. Besides, the users should be cautious about the potential risk of fatigue or musculoskeletal disorders while typing so fast.

**Keywords:** Computer work, Exposure measurement methods, Upper limb

### Reference:

Liang Huey-Wen, Hwang Yaw-Huei, Chang Fu-Han. Comparison of utility and users' typing performance of different input methods. *Ergonomics*. 2009; 52:1153–1161.  
Health RA, Willcox CH. A stochastic model for inter-keypress times in a typing task. *Acta Psychol*. 1990;75:13–39.



## USING EMG TO EVALUATE ERGONOMIC PROBLEMS AMONG THE HAND OF MOUSE OPERATORS

LIN P.H., LU C.W., SU S.B.

*Graduate Institute of Occupational Safety and Health Kaohsiung Medical University, Taiwan*

### **Aims:**

The main objectives of this study were to observe the alternations of muscle fatigue resulting from the influence of continuous computer mouse using and to evaluate the applicability of surface electromyography (sEMG) in characterizing low-force dynamics contractions.

### **Methods:**

EMG was used to monitor the activities of right extensor indicis proprius, right flexor carpi ulnaris, right middle deltoid and right upper trapezius during the computer game playing. At the beginning, the end of playing game, respectively, subjects were asked to assess the upper-extremity muscles fatigue by a self-report questionnaire.

### **Results:**

All subjects showed a decreased muscular activity during computer mouse task. A high percentage of discomfort in the shoulder, wrist and finger is observed among females. The males showed high percentage of discomfort in the wrist, finger and palm.

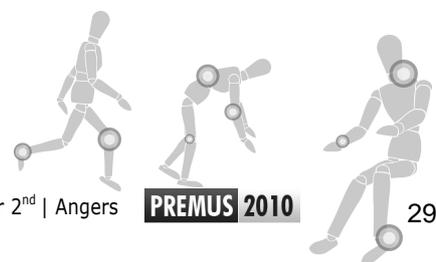
### **Conclusion:**

The findings of study showed that all target muscles presented significant muscle fatigue by EMG measurement after two hours computer mouse use. It was also found that the extent of self-report fatigue of all parts of upper-extremity increased. According to our study, rest breaks will positively influence the pattern of muscle activation, and is a meaningful strategy for increasing comfort and health.

**Keywords:** Muscle activity, Postures, physical exposure, Upper limb

### **References:**

- Perotto A. O., 2005. Anatomical guide for the electromyographer - The limbs and trunk. Springfield, Charles C Thomas.  
Johnson P. W., Lehman, S.L., Rempel, D.M., 1996. Measuring muscle fatigue during computer mouse use. In: Proceedings of the 18th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Amsterdam, Holland, pp. 1454-  
Cook C., Burgess-Limerick R., Chang S., 2000. The prevalence of neck and upper extremity musculoskeletal symptoms in computer mouse users. *Int. J. Ind. Ergon.* 26, 347–356.



## A PILOT FOR A RANDOMIZED CONTROLLED TRIAL INTO THE EFFECTIVENESS OF AN ALTERNATIVE MOUSE ON PAIN/DISCOMFORT, RESULTS ON FEASIBILITY AND EFFECTIVENESS

STEENSTRA I.<sup>1,2</sup>, KING T.<sup>1</sup>, VAN EERD D.<sup>1</sup>, AMICK B.C.<sup>1</sup>

<sup>1</sup> Institute for Work & Health, Toronto, Canada - <sup>2</sup> University of Toronto, Dalla Lana School of Public Health, Canada

### Aims:

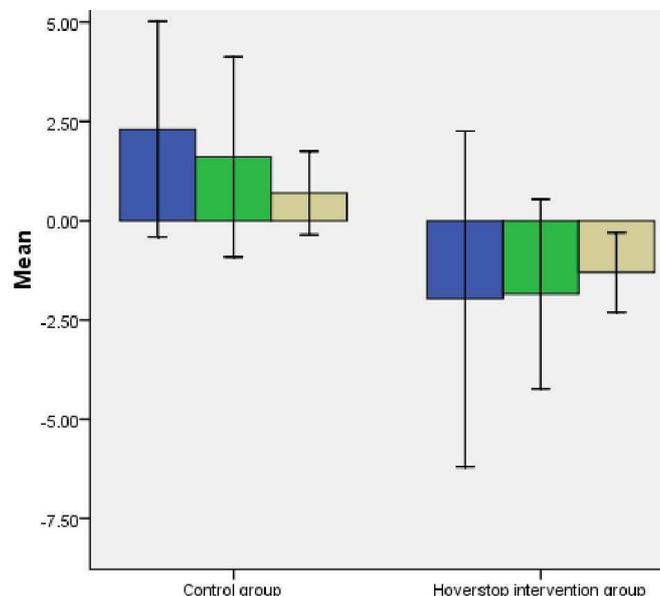
A pilot study was conducted to examine the feasibility of a randomized controlled trial into the effectiveness of an alternative mouse for the reduction of upper extremity complaints in office workers. The mouse provided feedback to the worker to rest their arm in front of them by gently vibrating if the worker's hand had been on the mouse for over 12 seconds without actively using it.

### Methods:

60 office workers were invited to participate and provide informed consent. After baseline measurements, workers were randomized in to 2 groups; one group received the new mouse with the vibration turned off and a second received the mouse with the vibration on. Follow up measurements took place after 12 and 26 weeks. Outcomes used were: Daily Symptom Survey administered daily for one week at each time point; and satisfaction with the mouse in the intervention group. Computer based monitoring software provided information on keyboard and mouse use. In order to increase response rates, each returned questionnaire was rewarded with a \$5 donation to a charity of choice. Participants were reminded several times if they had forgotten to fill out the online questionnaire.

### Results:

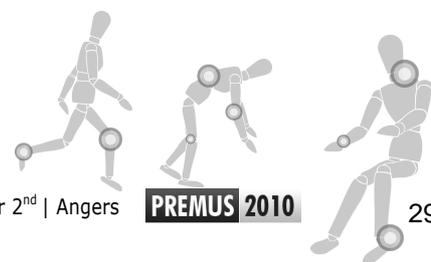
23 people participated (response rate=38%). We could not collect data on the representativeness of our final sample. One participant stopped working right after baseline and therefore was not included in the analysis. The retention rate of the remaining 22 subjects was 100%. 50% of the mouse users were very satisfied with the mouse, 50% were not. Intention to treat analysis showed statistically significantly less upper extremity and shoulder pain in the intervention group compared to controls. Regression analyses (adjusted for baseline and T1) and T-tests of difference scores gave similar results. A sensitivity analysis showed that one outlier influenced the results substantially. Removing this outlier resulted in a non significant difference in upper extremity and shoulder pain in the intervention group compared to controls. However, effects were still in favour of the intervention. The ratio of mouse use to total computer use did not change significantly over time between groups.



### Conclusion:

Taking the possibly more representative results from our sensitivity analysis, a sample size calculation shows we will need a sample size of 60 office workers to have sufficient power in a larger study. With a response rate of 38%, we will need a source population of 158 workers. If we want to look at subgroups, we would need to increase that size. This pilot shows that it is feasible to perform a randomized controlled trial on the effectiveness of this promising intervention.

**Keywords:** Computer work, upper limb, pain, chronic pain



## **GUIDELINES TO PREVENT COMPUTER-RELATED MUSCULOSKELETAL DISORDERS IN CHILDREN**

STRAKER L., JOHNSON P., DENNERLEIN J.T., BURGESS-LIMERICK R.

*Curtin University, University of Washington, Harvard University, The University of Queensland, USA*

### **Aims:**

Many children, particularly in affluent communities, now use computers frequently and for considerable durations. Initial evidence suggests children experience computer-related discomfort and disorders. It has been suggested that guidelines are needed as part of a strategy to minimise discomfort and development of musculoskeletal disorders related to computer use (Straker et al. 2009). The aim of this paper was to review available evidence to support guidelines specifically for child use of computers.

### **Methods:**

A narrative review of child and adult literature concerning the physical aspects of human-computer interaction was undertaken.

### **Results:**

Based on the evidence 12 guidelines were developed. These related to aspects of the task, the workstation and the user. Workstation aspects included the design of the desk, chair, display and input devices.

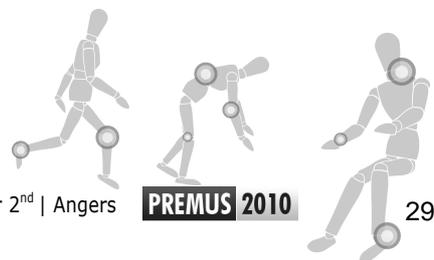
### **Conclusion:**

High and growing use of computers by children, along with reports of discomfort, suggest the need for guidelines to prevent the development of computer-related musculoskeletal disorders in children. The paper proposes 12 guidelines which are supported by the literature. These guidelines could be used as the basis for education of children, teachers and parents as well as informing equipment design and choice.

**Keywords:** Computer work, Early prevention, Other

### **Reference:**

Straker, L., Pollock, C., & Maslen, B. (2009). Principles for the wise use of computers by children. *Ergonomics*, 52, 11, 1372-1385.



## ADOLESCENT SPINAL PAIN: A KEY TARGET FOR MULTIDISCIPLINARY PREVENTION OF MUSCULOSKELETAL DISORDERS

STRAKER, O'SULLIVAN, SMITH, BEALES, CAMPBELL, BEAR

### Aims:

Spinal pain prevalence is known to increase dramatically over adolescence. Most people appear to experience their first episode during adolescence, and this appears to increase the risk of spinal pain in adulthood. Whilst the high adolescent prevalence rate is widely accepted, the importance of adolescent spinal pain is not. Some authorities consider that spinal pain is a normal developmental experience and should not be the focus of attention. The aim of this paper was to examine whether adolescent spinal pain is important by considering its impact.

### Methods:

1290 adolescents in the Western Australian Pregnancy (Raine) Cohort Study provided information on their experience of spinal pain and its impact on health service utilisation, school absenteeism and activity impairment at 17 years of age.

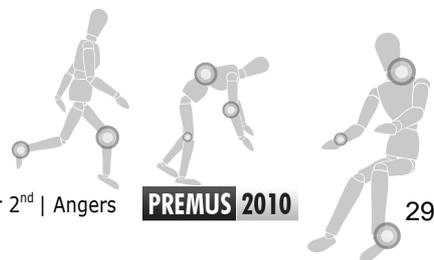
### Results:

Lifetime prevalence of neck/shoulder and low back pain were 45% and 49% respectively. Pain lasting 3 months or more either intermittent or continuous was reported by 20% and 4% for neck/shoulder pain and 24% and 6% for back pain. Health service utilisation (taking medication for pain relief or seeking medical treatment) was reported by 13-15% for neck/shoulder pain and 16-18% for low back pain. 8% missed school or work due to neck/shoulder pain and 9% due to low back pain. 16-17% reported that neck/shoulder pain interfered with normal activities or recreational physical activities and 18-21% reported this interference by low back pain.

### Conclusion:

Our findings not only confirmed earlier studies showing the high prevalence of spinal pain by late adolescence but also extended this data to clearly show for the first time the impact of spinal pain experience in adolescence. The clear impact of neck and low back pain in adolescence refutes prior conceptions of this disorder as a non-important developmental issue. Rather, the data highlight an important musculoskeletal issue which should be a key target for prevention. Other data from this cohort highlight the potential to address modifiable physical, psychosocial and lifestyle risk factors in prevention initiatives to reduce the burden of this disorder in adolescence and the risk of future burden in adulthood.

**Keywords:** Back pain, neck pain, adolescence, prevention, musculoskeletal disorders



## PERCEIVED EFFORT WHILST USING MOBILE COMPUTING DEVICES OF DIFFERENT TYPES

HOGG N., WELLS R.

University of Waterloo, Waterloo, Ontario, Canada

### Aims:

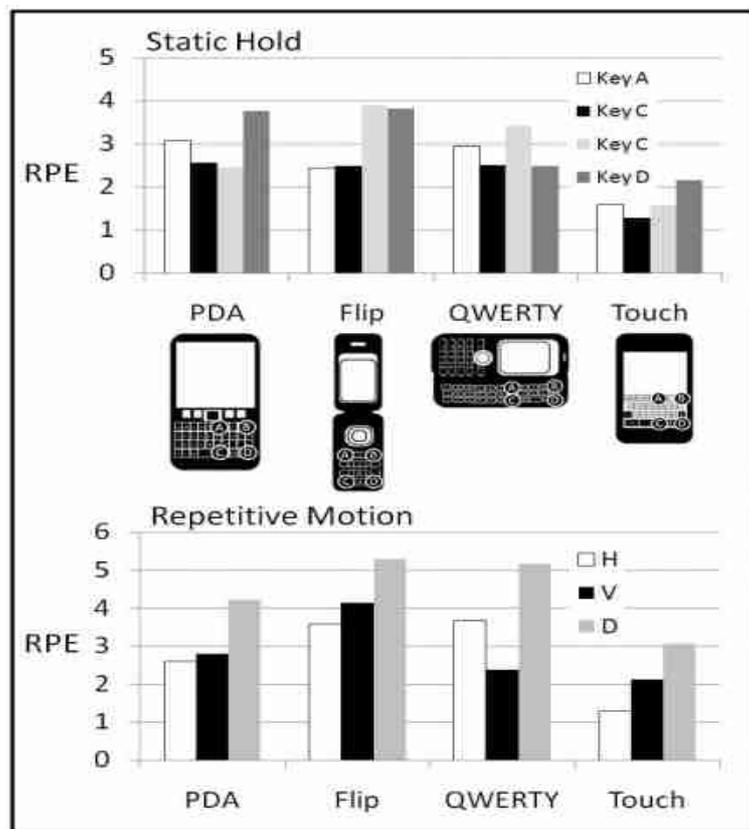
Use of hand-held mobile computing devices is thought to lead to the development of musculoskeletal disorders. This paper reports on exertions whilst using four such devices.

### Methods:

20 male and female students performed standardized tasks on four mobile devices: A PDA, a “flip” phone, a device with a pull-out “QWERTY” keyboard and a touch screen device. The “flip” phone was used with the right hand and the others with both hands. Participants held down keys at the four corners of the keypads for 20 seconds then rated the perceived exertion in their hands and thumb on a 10 point scale. They then performed repetitive pressing of keys in horizontal, vertical and diagonal directions for 10 seconds.

### Results:

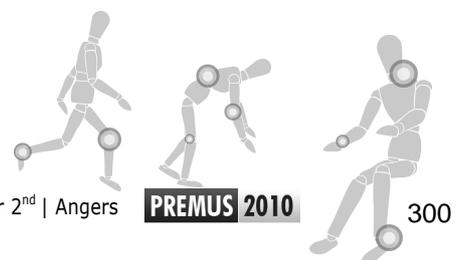
For both static holds and repetitive motion, device type and key conditions show statistically significant effects ( $P < 0.0001$ ) on perceived exertion with no significant interaction effects. For the static hold, keys in the near bottom region required higher efforts and flip phone showed the highest efforts. For repetitive motions, horizontal motions resulted in the least effort and diagonal motions the most effort. The touch screen device showed least effort over both tasks and keys used.



### Conclusion:

The four devices were chosen to span the range of current forms. Using a “flip” phone appears to create the highest demand on the thumb, likely due to the thumb flexion required to reach the keys and to also hold the device.

**Keywords:** Biomechanics, exposure measurement methods, upper limb



## MUSCLE REST PATTERNS IN THE UPPER TRAPEZIUS AND NECK EXTENSOR MUSCLES DURING TWO COMPUTER-BASED TASKS IN EXPERIMENTAL AND IDIOPATHIC NECK PAIN

WONG T.L., JOHNSTON V., SOUVLIS T.

*The University of Queensland, Brisbane, Australia*

### Aims:

Strains to muscles are amongst the most commonly reported work-related injury, possibly due to changes in workplace technology over the last few decades. Computer users are consistently reported as having increased risk of neck and/or shoulder symptoms which may be attributed to prolonged low-level muscular tension, along with awkward or static postures. The aims of this study were to explore: 1) if subjects with self-reported idiopathic neck pain (cases) could be differentiated from controls (no neck pain) in terms of muscle rest time (MRT) and/or muscle activity levels in the upper trapezius and neck extensor (splenius) muscles while performing low load computer-based tasks; and 2) if cases demonstrated altered levels of MRT and muscle activity compared to controls during these tasks following experimental pain.

### Methods:

Twenty-six healthy subjects participated in the study, fourteen cases (mean duration of neck pain of 7.6 years) and nine controls. Surface electromyography was used to obtain myoelectric signals from the upper trapezius and splenius muscles bilaterally during two five minute computer-based tasks: standard text typing and stroop-stress task. The control group participated in two experimental sessions before and after a continuous infusion of hypertonic or isotonic saline into the right upper trapezius muscle.

### Results:

Cases (N=14) demonstrated significantly higher EMG activity ( $p<0.05$ ) compared to controls (N=9) pre- and post hypertonic injection in the upper trapezius bilaterally during the typing and stroop-stress task. MRT was significantly higher ( $p<0.05$ ) in the right upper trapezius for controls pre- and post hypertonic injection compared to cases during both tasks. Within control comparisons between pre- and post hypertonic injection demonstrated greater MRT pre-injection in the upper trapezius bilaterally during the typing tasks, although not statistically significant.

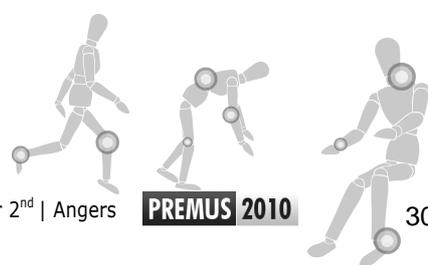
### Conclusion:

Those with self-reported neck pain demonstrated greater trapezius muscle activity and reduced muscle rest compared to those without neck pain during low load computer tasks. Reduced rest time in the trapezius muscle was observed in response to experimental pain during both computer tasks. These findings suggest that pain can induce an increased motor response while performing stressful and repetitive low load computer tasks. In addition, those with idiopathic neck pain displayed greater trapezius muscle activity and less rest time compared to experimentally induced pain suggesting that pain is not the only factor contributing to the increased motor response. Further research is needed to investigate the modulating effects of acute compared to chronic pain on muscle rest patterns during low load

**Keywords:** Muscle activity, computer work, pain, chronic pain

### References:

- Falla D, Bilenkij G, Jull G. Patients with chronic neck pain demonstrate altered patterns of muscle activation during performance of a functional upper limb task. *Spine* 2004; 29(13): 1436-1440.
- Johnston V, Jull G, Darnell R, Jimmieson NL, Souvlis T. Alterations in cervical muscle activity in functional and stressful tasks in female office workers with neck pain. *European Journal of Applied Physiology* 2008; 103: 253–264.
- Thorn S, Sogaard K, Kallenberg LA, Sandsjo L, Sjogaard G, Hermens HJ, et al. Trapezius muscle rest time during standardised computer work--a comparison of female computer users with and without self-reported neck/shoulder complaints. *Journal of Electromyography and Kinesiology* 2007; 17(4): 420-427.



## HEALTH CARE SECTOR

### ERGONOMIC EXPOSURES TO BACK DISORDER RISK FACTORS AMONG HEALTHCARE WORKERS: A DESCRIPTION AND COMPARISON OF HOSPITALS AND NURSING HOMES

BOYER J., TESSLER J., PARK J., PUNNETT L. AND THE PROMOTING HEALTHY AND SAFE EMPLOYMENT IN HEALTHCARE TEAM.

*University of Massachusetts Lowell, Department of Work Environment, Lowell, MASSACHUSETTS, USA*

#### Aims:

Efforts to provide a comprehensive description of back disorder risk factors across healthcare job categories and industry sub-sectors are few. The study aims were to use an observational exposure assessment method to comprehensively describe and compare the prevalence of manual handling activities, trunk posture, and work organization factors in hospital and nursing home jobs.

#### Methods:

The Posture, Activities, Tools, and Handling (PATH) work sampling method was used to categorize the ergonomic exposure frequencies of hospital and nursing home job titles. Sampling of jobs was guided by a-priori ergonomic job groups developed according to their expected prevalence and variability of back disorder risk factors. Job title observation frequency was computed for each posture and activity variable. Job group medians were determined for each exposure frequency distribution. Between-group and between facility variability in geometric mean exposures was assessed through generalized linear models. A PATH Coversheet (CS) checklist was developed to capture contextual and supplemental data related to biomechanical and work organization risk factors.

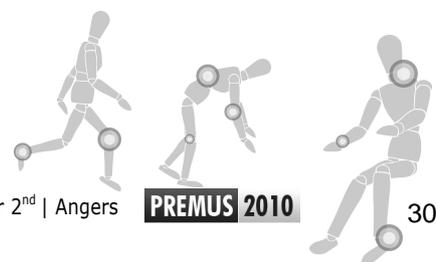
#### Results:

Fourteen ergonomic exposure groups were constructed from 468 facility job titles that existed in two hospitals and two nursing homes. A 180 employee sub-set in 100 facility job titles was actually observed. A total of 23,003 direct multi-moment observations were collected over 249 observation periods of 1 to 10 hours in duration. Trunk flexion and manual handling exposures were two-to-seven times greater than those in hospitals. In clinical jobs, nursing aides and orderlies, staff nurses, and rehabilitation therapists had the highest median exposures to trunk flexion. Among support positions, laundry and custodial workers in hospitals had 4 to 5 times greater manual handling exposure than other jobs. Housekeepers in nursing homes had the highest exposures to trunk flexion; relative to all other clinical and non-clinical jobs in both facility types. Work routinization and overtime work were found to be most common in housekeepers and nurses, respectively. Group differences were statistically significant for trunk flexion, twisting/bending, manual handling > 10 pounds and > 50 pounds, standing, and sitting. Exposures by facility type were only significant for manual handling > 50 pounds and time sitting.

#### Conclusion:

There is the clear evidence that patient care job titles are not the only ones exposed to high physical and organizational risk factors in the healthcare industry. High exposures to non-neutral trunk postures are widespread and exist in addition to the commonly reported heavy lifting requirements of healthcare work.

**Keywords:** Health care workers, Exposure measurement methods, Back, low back



## WORK-RELATED MUSCULOSKELETAL DISORDERS AND PREVENTION AMONG HOME HEALTHCARE WORKERS

GARG A., HEGMANN K.T., KAPELUSCH J., THIESE M.

*University of Wisconsin-Milwaukee, USA*

### **Aims:**

The objectives of this study were to (i) quantify different hazards and prevalence of work-related disorders (WMSDs) and their sources among home health care (HHC) workers and (ii) perform an intervention study to determine effectiveness of battery-operated hoists in HHC.

### **Methods:**

A questionnaire was rendered to 883 HHC workers in Wisconsin, Iowa, Utah and Canada to determine self-reported work-related musculoskeletal disorders (WMSDs) and tasks perceived to be associated with these MSDs. The researchers visited more than 100 home health care residents in their homes and observed service provided to them by HHC workers.

Ergonomic interventions were implemented in 38 homes. These homes were provided with battery operated total and sit/stand lifts and slip sheets as needed. All nursing aides were trained in proper use of these assistive devices.

### **Results:**

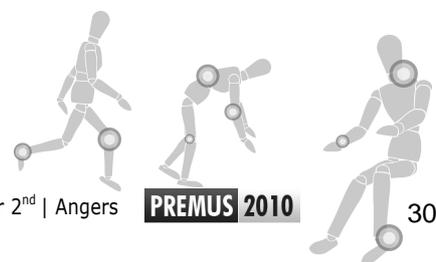
Overall 12-month prevalence for low back, shoulder and neck pain was 48.9%, 30.6% and 31.8%. In the past 12 months 58.1%, 45.8%, 30.1% and 26.4% of aides, nurses, therapists and office workers suffered from work-related low-back pain, respectively; 33.5%, 31.7%, 20.4% and 30.6% from shoulder pain; and 32.9%, 34.7%, 21.5% and 24.5% from neck pain. The crude 1-year prevalence rate ratio (PRR) for aides and nurses for all three WMSDs ranged from 1.68 to 3.44 and were statistically significant as compared to the low exposure group (combined therapists and office workers). The primary cause for these WMSDs was perceived to be manual lifting and transferring of residents (lifting residents off the floor (71%), lifting/repositioning in bed (55%), transfers between beds and wheel chairs (51%), between toilets and wheelchairs (48%), etc.). Other hazards faced by HHCWs included slips/trips/falls, motor vehicle crashes, animal bites, sharps injuries and assaults/violence.

A comparison of post- with pre-intervention data showed that battery-operated hoists significantly reduced stresses to caregivers' low back and shoulders ( $p < 0.001$ ). The caregivers found these devices to be easier and safer to use ( $p < 0.001$ ). These devices were reported to be more comfortable (71%) and safer (50%) by residents.

### **Conclusion:**

HHC aides are at high risk for WMSDs. Battery operated hoists other simple devices observed in some homes appear to have substantial potential to reduce stresses to caregivers.

**Keywords:** Postures, physical exposure, Health care workers, Intervention studies



## WORK-RELATED MUSCULOSKELETAL DISORDERS IN FEMALE SWEDISH PHYSICAL THERAPISTS WITH MORE THAN 15 YEARS OF JOB EXPERIENCE: PREVALENCE AND ASSOCIATIONS WITH WORK EXPOSURES

GROOTEN W., WERNSTEDT P., CAMPO M.

*Karolinska Institutet - Dep of Public Health - Div. Occ and Environ Med, Sweden.*

### **Aims:**

The objective of this study was to determine the prevalence of work-related musculoskeletal disorders WRMDs for female physiotherapists with more than 15 years of job experience and to determine associated risk factors.

### **Methods:**

A self-administered postal questionnaire was sent to 203 female physiotherapists with more than 15 years of job experience. Unconditional logistic regression was used to study the association between job exposures and the risk for WRMDs.

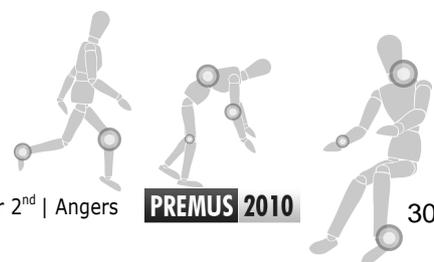
### **Results:**

The questionnaire was returned by 131 physiotherapists (64.5%). Of 99 who answered specific questions about WRMDs, 52 (53.5%) were affected by WRMDs in at least one part of the body. Regions most affected were the hand/wrist ( $n = 31$ ; 58.5%) and the lower back ( $n = 30$ ; 56.5%). For hand/wrist pain, associations were found with orthopedic manual therapy techniques (adjusted Odds Ratio [OR] = 3.90; 95% Confidence interval [CI] = 1.2-13.1), working in awkward or cramped positions (OR = 4.96; 95% CI = 1.3-18.7) and high psychological job demands (OR = 4.34; 95% CI = 1.2-15.0). For lower back pain, associations were found with working in awkward or cramped positions (adjusted OR = 6.37; 95% CI = 1.6-24.7), and kneeling or squatting (adjusted OR = 4.76; 95% CI = 1.4-15.9).

### **Conclusion:**

More than 50% of the female physiotherapists reported WRMDs. General physical and psychosocial work-related exposures, as well as specific therapy tasks, were strongly associated with WRMDs. Larger, longitudinal studies are needed to determine the direction of causality.

**Keywords:** Postures, physical exposure, Health care workers, Older workers



## THE CULTURES OF CARING AMONG HEALTHCARE PROFESSIONS AND WORKER SAFETY IN ACUTE CARE PATIENT HANDLING

MYERS D.J., SCHOENFISCH A.L., LIPSCOMB H.J.

*Duke University, Durham, North Carolina, USA*

### **Aims:**

The terms "safety culture" and "safety climate" have become prevalent in studies of work-related injury and musculoskeletal disorders (MSDs). Although they represent quite different things among researchers, these concepts often address elements of culture that bespeak safety explicitly. We instead focus on how the meaning of work itself may affect safety. A sociological view of culture is used to explore how cultural differences in the meaning of care-giving held by nurses and physical/occupational therapists (PT/OT) affect the perception and use of patient lifting devices.

### **Methods:**

Survey data were collected from nursing staff and PT/OT at two hospitals (n=245). Questionnaires ascertained information on work unit, age, tenure, and equipment use. Text data were analyzed for common themes related to equipment use and suggestions for improvement. Focus groups (n=12; participants n=56) were conducted between 2004–2009 with nurses, PT/OT and other healthcare staff members to explore issues concerning the policy shift and use of the lift equipment. Groups were audio-recorded and transcribed; text analysis software (N6-QSR) was used for content analyses. This was part of an ongoing evaluation of an institutional policy shift to a 'minimal manual lift environment' regarding patient handling and purchase of patient lift/transfer devices in a tertiary care hospital and an affiliated community hospital in the USA.

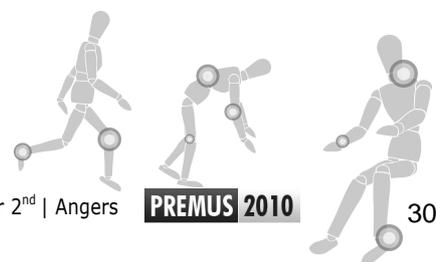
### **Results:**

Focus group and open-ended survey questions reveal that cultural ideals of care-giving differ between these healthcare occupations. Nurses have a compassionate view of care and see themselves as minimizing patient pain and discomfort. The role of the lift equipment in the nurses' culture of caring is to protect the workers, not the patients. In a culture where the patient comes first, there is a low inclination for nurses to use the equipment. PT/OT have a "tough love" approach to care and see some patient pain as a normal part of recovery. Since lift equipment is used to help mobilize patients, and is therefore consonant with care-giving, the PT/OT culture of caring is conducive to its use.

### **Conclusion:**

Different cultural approaches to the nature of care-giving among healthcare professions may lead to different propensities to using lift equipment. The meaning of work itself may therefore affect workers' safety. Analyses of "safety culture" and "safety climate" without consideration of an occupation's culture might overlook factors important for creating effective safety interventions.

**Keywords:** Health care workers, Intervention studies, Social aspects of MSD.



**PARAMEDICS ON THE JOB: A BIOMECHANICAL AND PHYSIOLOGICAL WORKPLACE ANALYSIS**

PRAIRIE J., CORBEIL P.

*Groupe de recherche en analyse du mouvement et ergonomie (GRAME), Université Laval, Québec, Canada***Aims:**

Sterud and al. (2006) demonstrated a higher prevalence of musculoskeletal disorders in a group of paramedics (PA) compared with the general population. Moreover, a significant link between physical work of PA and musculoskeletal disorders were observed in a sample of 1500 PA (Aasa and al. 2005). The aims of this study are to describe the biomechanical and physiological task requirements carried out by PA and to quantify working postures during physically demanding tasks made under real working conditions.

**Methods:**

Eleven North American PA performed 59 interventions which totalled more than 200 hours of observations and measurements. For biomechanical and physiological recordings a digital video camera, heart rate monitor, Borg RC10 scale and a CUELA measuring system (computer-assisted recording and long-term analysis of musculoskeletal loading, BGIA) were used. The CUELA is a device worn on the back and measured (100 Hz) the back sagittal flexions (SF) and rotations (BR). PA wore this equipment during an entire shift (8-12 hours) but were filmed only during the interventions.

**Results:**

Physical requirements of moderate or greater ( $\geq 3/10$  Borg RC10 scale) were observed in 20% of the interventions. The moderate physical interventions, when compared with the easier, require higher physiological demands (% heart rate maximal and mean). Sagittal flexions are not significantly different between the types of intervention (i.e. task difficulty). On the other hand, the PA spent more than 47% of the time in positions at risk for back problems in both interventions. Moreover, when the task became difficult physically, they employed more constraining back rotation postures to execute their physical task (28% vs. 13%).

**Table.** Comparisons between easy and moderate interventions for back movements and physiological data

variables (mean)	Easy interventions (<3 Borg RC10 scale)	Moderate interventions ( $\geq 3$ Borg RC10 scale)
PA age (years)	35	38
% heart rate (maximal)	<b>60% **</b>	<b>68% **</b>
% heart rate (mean)	<b>45% **</b>	<b>52% **</b>
Patient weight (kg)	69,9	80,3
Intervention time (minutes)	22	20
Physical requirements (Borg RC10 scale,)	<b>1,4**</b>	<b>4,9**</b>
% time in light SF ( $\geq -2^\circ$ and $< 20^\circ$ )	55%	46%
% time in moderate SF ( $\geq 20^\circ$ and $< 40^\circ$ )	21%	19%
% time in high SF ( $\geq 20^\circ$ and $< 40^\circ$ )	24%	35%
% time in light BR ( $\geq -10^\circ$ et $\leq 10^\circ$ )	<b>87% **</b>	<b>72% **</b>
% time in moderate BR ( $\geq -20^\circ$ and $< -10^\circ$ ; $> 10^\circ$ and $\leq 20^\circ$ )	<b>12% **</b>	<b>22% **</b>
% time in high BR ( $< -20^\circ$ and $> 20^\circ$ )	<b>1% **</b>	<b>6% **</b>

\*\* t-test significant  $p \leq 0.05$  between easy interventions and moderate interventions.

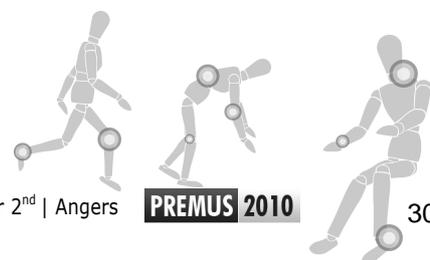
**Conclusion:**

For paramedics there is a possible risk of musculoskeletal disorders even in easy interventions and that it increases with the physical demands of the intervention.

**Keywords:** Biomechanics, Health care workers, Back, low back

**Reference:**

Sterud T. et al. Health problems and help-seeking in a nationwide sample of operational Norwegian ambulance personnel. BMC Health Services Research 2006; 6: 82.  
 Aasa et al. Relationship between Work-related factors and disorders in the neck-shoulder and low-back region among female and male ambulance personnel. J Occup Health 2005; 47: 481-489.  
 Borg, G. The Borg CR10 Scale® Folder. A method for measuring intensity of experience. Hasselby, Sweden. Borg Perception, 2004.



**PROCESS VARIATIONS, ERGONOMIC STRESSES AND QUALITY**

CARRASQUILLO V., ARMSTRONG T.J., HU J., LEY K., RIGGS R., YU D.

*University of Michigan, USA***Aims:**

This study investigated the hypothesis that work variations (e.g. product complexity, abnormal work elements) create factors (e.g. exertion frequency, duration) that are related to work-related musculoskeletal disorders and work defects [1, 2].

**Methods:**

A hospital food preparation line in which workers placed food on trays as they moved on a conveyor at 35.7ft/min was selected for examining the proposed hypothesis. Trays are inspected at the end of the conveyor and then removed. If a tray is not removed before it reaches the end, a sensor makes the whole line stop. Time studies were performed on selected workers to measure cycle times and to identify sources of cycle variation. Finally, ProModel [3] was used to simulate the tray line as a queuing model in which a customer (tray) moves from one server (workstation) to the next.

**Results:**

The standard time was computed as  $4.43 \pm 0.52$  sec, but the average observed cycle time was  $11.25 \pm 5.03$  sec. When workers got behind they would reach further for the tray, which required more time and reduced the recovery time. In some cases they would hold the tray in position against the moving line, which delayed the arrival of that and subsequent trays at the following workstations. The workers at the following workstations often held tools, food or plates while they waited.

Line stoppages due to workers getting behind accounted for 86% of the variance and caused other workers holding tools, or dishes to wait. The other 14% of the variance can be attributed to food selection complexity and additional irregular work elements. The cause of most stoppages occurred at the inspection station (average work time  $12.6 \pm 3.6$  sec). A sensor would stop the entire line if the tray was not removed before it got to the end. By extending the line at the inspection station from 1ft to 4.75ft, the work should be completed before the conveyor stops most of the time. This alternative was evaluated with a simulation model. It showed the frequency of conveyor stops decreases from to 22.3 sec to 10.6sec and total work time was reduced by 48%.

**Conclusion:**

Irregular work elements and process variations due to complexity may result in increased reaching, increased work time, reduced recovery time and forceful exertions. Also they may result in increased waiting and slowed production. Simulation is a useful tool for investigating how jobs can be modified to reduce ergonomic stresses.

**Keywords:** Postures, physical exposure, Work organization, Upper limb

**References:**

- [1] L.Lin, C.G. Drury, and S.-W. Kim (2001). Ergonomics and Quality in Paced Assembly Lines. *Human Factors and Ergonomics in Manufacturing*, Vol. 11 (4) 377-382
- [2] MacDuffie, J.P.; Sethuraman, K.; and Fisher, M.L., 1996, "Product variety and manufacturing performance: evidence from the international automotive assembly plant study", *Management Science*, v. 42, n. 3, pp. 350-369.
- [3] ProModel Corporation, version 7, 2835 Carpenter Road, Ann Arbor, Michigan 48108, <http://www.promodel.com/>



## LUMBAR-LOAD QUANTIFICATION AND OVERLOAD-RISK PREVENTION FOR HEALTHCARE WORKERS DURING PATIENT-HANDLING ACTIVITIES

JÄGER M., JORDAN C., THEILMEIER A., LUTTMANN A.

IfADo – Leibniz Research Centre for Working Environment and Human Factors, Dortmund University of Technology, Dortmund, Germany

### Aims:

Healthcare work and, in particular, transferring patients in the bed or from the bed to a chair etc. may lead to high load on the lumbar spine (Marras et al. 1999, Schibye et al. 2003) and to low-back complaints or disc-related lumbar diseases. The aim of the actual study was to describe quantitatively a subject's spinal load for an enlarged sample of typical patient transfers, to examine various measures for work design and to derive potentialities for a biomechanically substantiated prevention.

### Methods:

In laboratory studies, the body movements of nurse and patient were captured via an optoelectronic system and several video cameras. The action forces at nurse's hands were recorded using a measuring bed, chair, floor and bathtub. For example, a common hospital bed was equipped with an additional framework between bedstead and bedspring frame, which were connected via tri-axial force sensors at the four corners. Subsequent 3-D dynamic simulation calculations were performed to predict typical lumbar-load indicators. The examined activities referred to transferring the patient within the bed, from a bed to a chair, from bed to bed, from the floor to upright standing and to moving the patient into the bathtub. If possible, the activities were performed in a conventional way, in an optimized way and using small aids like sliding boards or mats. In total, more than 160 transfers were analyzed with respect to lumbar load.

### Results:

Spinal load is often very high for the healthcare workers. According to the 15 different tasks, the mean value for the lumbosacral-disc compressive force ranges between 1.8 and 6.9 kN, the range is 1.6 to 8.9 kN. Comparison of the lumbar-load values with corresponding age-and-gender specific recommendations for maximum loading (Dortmund Recommendations, Jäger et al. 2001) shows that lumbar load exceeds the recommended values for conventional task execution for most activities.

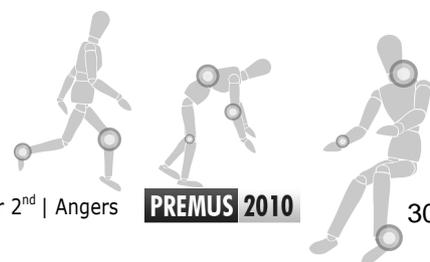
### Conclusion:

Load reduction can be achieved by an optimized task execution. However, this load decrease is not sufficient not in all cases, especially, when high-loading activities are performed by older persons. In particular in these cases, small aids should be used to achieve a vital load reduction for the lumbar spine. In conclusion, design measures like a biomechanically optimized transfer technique and the application of small aids are advised to limit the biomechanical overload risk for the healthcare worker during patient-transfer activities.

**Keywords:** Biomechanics, Health care workers, Back, low back

### References:

- Jäger M, Luttmann A, Göllner R. Analysis of lumbar ultimate compressive strength for deriving recommended lumbar-load limits. In: Müller R, Gerber H, Stacoff A, editors. Book of abstracts, 18th Congress of the International Society of Biomechanics. Zürich: Laboratory for Biomechanics, 2001. p 263-264.
- Marras W S, Davis K G, Kiring B C, Bertsche P K. A comprehensive analysis of low-back disorder risk and spinal loading during the transferring and repositioning of patients using different techniques. *Ergonomics*. 1999;42: 904-926.
- Schibye B, Faber Hansen A, Hye-Knudsen C T, Essendrop M, Böcher M, Skotte J. Biomechanical analysis of the effect of changing patient-handling technique. *Appl Ergonomics*. 2003;34: 115-123.



## THE OCCURRENCE OF MUSCULOSKELETAL SYMPTOMS IN SOUTH AFRICAN NURSES

NYANTUMBU B.M., KIELKOWSKI D., REES D.

*National Institute for Occupational Health, University of Witwatersrand, Johannesburg, South Africa*

### Aims:

To determine the prevalence of musculoskeletal symptoms and associated risk factors in public hospital nurses who perform patient handling tasks.

### Methods:

The study was cross-sectional and conducted in two public hospitals (A and B). A modified baseline questionnaire designed for the multinational project called “Cultural and Psychological Influences on Disability” was administered at interview to 252 nurses. The questionnaire asked about personal details, work activities, risk factors and musculoskeletal symptoms. Data were analysed using STATA 10.0. Adjusted OR's were derived from different models developed for each symptom investigated in the study using logistic regression.

### Results:

The prevalence of any pain which is pain from any of the selected body parts in the study (low back, neck, shoulder, elbow, wrist or hand and knee) was 84.1% in the past 12 months and 57.8% in the past month. The most prevalent pain reported in the past 12 months and past month respectively was low back pain (58.3% and 35.7%), shoulder pain (41.3% and 23.0%), neck pain (39.7% and 21.1%), knee pain (32.5% and 21.4%) and wrist or hand pain (22.6% and 14.3%). The least prevalent pain was elbow pain reported by 13.5% of nurses in the past 12 months and 5.9% in the past month. In multivariate analysis significant risk factors for site specific pain were kneeling or squatting with low back pain (OR 2.3, 95% CI 1.3-4.4), neck pain (OR 1.9, 95% CI 1.1-3.5), shoulder pain (OR 2.3, 95% CI 1.3-4.3) and elbow pain (OR 4.4, 95% CI 1.9-9.8); job dissatisfaction with low back pain (OR 2.1, 95% CI 1.1-3.8), shoulder pain (OR 1.9, 95% CI 1.1-3.5), wrist or hand pain (OR 2.1, 95% CI 1.1-3.9) and knee pain (OR 2.2, 95% CI 1.2-3.9); job insecurity with neck pain (OR 3.4, 95% CI 1.7-7.3) and shoulder pain (OR 2.9, 95% CI 1.4-5.7); working in Hospital B with low back pain (OR 3.1, 95% CI 1.7-5.5) and shoulder pain (OR 3.1, 95% CI 1.6-6.5).

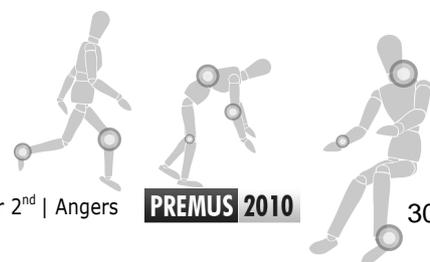
### Conclusion:

This study has found a high prevalence of musculoskeletal symptoms in nurses. This finding suggests that the risks for developing musculoskeletal disorders have not been controlled in the hospitals studied. Therefore, there is a need to find and implement appropriate and effective strategies to reduce the risk of musculoskeletal disorders in nurses.

**Keywords:** Back, low back, Neck, Pain, chronic pain.

### References:

- Trinkoff AM, Lipscomb JA, Geyer-Brown J. Musculoskeletal problems of the neck, shoulder, and back and functional consequences in nurses. *Amer J of Ind Med.* 2002;52(7) 41(3):170-78.
- Madan I, Reading I, Palmer KT, Coggon D. Cultural differences in musculoskeletal symptoms and disability. *Int J Epidemiol.* 2008;37(5):1181-1189.
- Pompeli LA, Lipscomb HJ, Schoenfisch AL, Dement JM. Musculoskeletal injuries resulting from patient handling tasks among hospital workers. *Amer J of Ind Med.* 2009;52(7)571-8.



## ERGONOMIC DEVICES REDUCE PHYSICAL LOAD DURING PATIENT HANDLING ACTIVITIES IN NURSING HOMES

KOPPELAAR E.<sup>1</sup>, KNIBBE J.J.<sup>2</sup>, MIEDEMA H.S.<sup>3</sup>, BURDORF A.<sup>1</sup>

<sup>1</sup> Department of Public Health, Erasmus MC, University Medical Center Rotterdam, The Netherlands – <sup>2</sup> KNIBBE J.J., Locomotion, Health Research and Consultancy, Bennekom, The Netherlands – <sup>3</sup> Netherlands Expert Center for Workrelated Musculoskeletal Disorders, Erasmus MC, University Medical Center Rotterdam, The Netherlands

### Aims:

This study aims to describe the required and actual use of ergonomic devices during patient handling activities, and to assess the effect of these ergonomic devices on reduction in physical load during patient handling activities.

### Methods:

This cross-sectional study took place in 17 nursing homes at the level of the individual nurse as well as the organization using self-administered questionnaires and structured interviews. Exposure to physical load during patient handling activities was assessed through real time observations at the workplace. Checklists were used for requirements on use of ergonomic devices and number of staff and patients in each ward within each organization. Interviews were conducted with nurses at site. A mixed-effect model for repeated measurements was used to determine the effect of ergonomic devices on physical load during patient handling activities, adjusted for individual and ward factors.

### Results:

In total, 735 patient handling activities were observed performed by 186 nurses with a total duration of 60 hours. The use of ergonomic devices when necessary was 69%. The use of ergonomic devices as well as a favorable ratio of nurses-per-patients at the ward decreased the frequency of forces exerted over 100N and duration of trunk postures with at least 300 flexion and/or rotation during patient handling activities with factors ranging from 1.4 to 22.0 (Table 1).

**Table 1** Determinants of exposure to physical load during patient handling activities, estimated by linear mixed effect model for repeated measurements.

	Device necessary and used		Ratio fte <sup>a</sup> nurse/patient	
	REF	(CI) <sup>b</sup>	REF	(CI) <sup>b</sup>
Transfer activity with patient				
Non-neutral trunk posture	1.01	(0.8-1.4)	1.49*	(1.1-2.0)
Exerted forces 100-230N	3.13*	(2.0-4.8)		
Exerted forces >230N	2.76*	(2.0-3.8)	1.50*	(1.1-2.0)
Personal care of patients <sup>c</sup>				
Non-neutral trunk posture	1.61*	(1.2-2.2)	1.31	(1.0-1.8)
Exerted forces 100-230N	1.00	(0.7-1.4)		
Exerted forces >230N	1.01	(0.8-1.2)		
Reposition patients within the bed (A) <sup>d</sup>				
Non-neutral trunk posture	1.84	(0.9-3.6)	0.94	(0.6-1.5)
Exerted forces 100-230N	1.92	(0.5-3.2)		
Exerted forces >230N	1.27	(0.6-2.5)		
Reposition patients within the bed (B) <sup>d</sup>				
Non-neutral trunk posture	0.95	(0.5-1.9)	1.00	(0.6-4.0)
Exerted forces 100-230N	1.70	(0.7-4.1)		
Exerted forces >230N	1.39	(0.7-2.7)		
Put on/ pull out anti-embolism stockings				
Non-neutral trunk posture	1.16	(0.7-1.9)	1.74*	(1.1-2.9)
Exerted forces 100-230N	21.97*	(10.9-44.3)		

\*p<0.1; <sup>a</sup>fte=full time equivalent; <sup>b</sup>REF = Reduction Exposure Factor, CI=95% Confidence Interval; <sup>c</sup> use of electric adjustable bed or adjustable shower chair; <sup>d</sup> A, use of slide sheet; B, use of electric adjustable bed.

### Conclusion:

The use of ergonomic devices during patient handling activities was high in the nursing homes. Use of ergonomic devices substantially reduced lifting, forceful movements, and awkward postures and, thus, will most likely contribute to the prevention of low back pain among nurses.

**Keywords:** Postures, physical exposure, Health care workers, Exposure measurement methods.



## USE OF A LIFT ASSIST TEAM IN AN ACUTE CARE HOSPITAL SETTING: PREVENTION OR TRANSFER OF RISK OF PATIENT-HANDLING INJURY?

SCHOENFISCH A.L., LIPSCOMB H.J., MYERS D.J.

Duke University, Durham, North Carolina, USA

### Aims:

A Lift Assist Team (LAT) was implemented at a tertiary-care medical center on three neurosciences units where nursing staff were at high risk of patient-handling injuries. LAT members were drawn from patient transporters. Through this case study, we summarize the development, implementation and experiences of the LAT and compare intermediate and longer-term measures of effect before and after implementation.

### Methods:

Data come from an ongoing study at the hospital to evaluate the effectiveness of patient lift and transfer equipment in preventing patient-handling injuries. Monthly unit-level audits captured information on equipment readiness, use and supplies. Focus groups were conducted separately with neuroscience nursing staff, physical and occupational therapy (PT/OT) staff, and the LAT at implementation and 3 years post-implementation to discuss the patient-handling policy, equipment use, communication and risk identification/management. Workers' compensation (WC) claims and full-time equivalents were used to calculate injury rates before and after implementation of the LAT.

### Results:

LAT members clearly valued their formal and time-intensive training from PT/OT and ergonomics staff. They expressed confidence and diligence in using and maintaining the lift equipment. Correspondingly, an increase in lift equipment use following implementation of the LAT was observed. They expressed the importance of assistance from nurses primarily as a means of obtaining guidance on keeping patients safe during transfers. Comparing their LAT role to that as a patient transporter, they highlighted an ability to get to know patients, assimilation into the nursing group, and increased job satisfaction; however, results suggest their integration onto the neurosciences units may also broaden the scope of the LAT's initially-defined job responsibilities. Nursing staff valued the LAT, reporting improved staff safety and patient care. The rate of WC claims for patient-handling injuries on the neurosciences units declined following implementation of the LAT; unstable rates preclude assessment of short-term changes in risk.

### Conclusion:

Increased lift equipment use and a reduction in the rate of patient-handling injuries among nursing personnel on the affected units likely reflect, in part, the LAT; however, monitoring the LAT's wellbeing is warranted to understand whether the risk of patient-handling injury is simply shifting from nursing personnel to the LAT. Although this research is focused on worker safety, evaluation of a lift team's importance may also rest partly on patient safety measures (e.g., pressure ulcers, skin tears).

**Keywords:** Health care workers, Methods in epidemiology, Intervention methods



## THE EVALUATION OF A TOOL TO MEASURE THE SUCCESS OF PATIENT HANDLING INTERVENTIONS; USING FIELD TRIALS ACROSS THE EU.

FRAY M., HIGNETT S.

HEPSU, Dept of Ergonomics, Loughborough University, UK Produced in partnership with Arjo Huntleigh Ltd

### Aims:

Previous research has found limited evidence for the benefits of patient handling interventions and poor levels of evidence for the reduction of work-related MSDs in healthcare. The Intervention Evaluation Tool (IET) is a complex performance measurement tool that evaluates the management systems for patient handling risk management. This paper describes field trials and the evaluation of the IET in 4 EU countries.

### Methods:

The development of the IET has been previously published (Fray and Hignett, 2009). Data from focus groups were coded using thematic and content analysis and integrated with a preference list from the group participants (9 countries, 44 participants), to give a ranked list of preferred outcomes. The IET, was developed utilising the most suitable measurement tools (Downs and Black 1998, Robson et al 2007) for each of the 12 most preferred outcomes.

The IET was translated, and used in field trials in 2 ward areas in 4 EU countries (UK, Finland, Italy, Portugal). A peer-review panel, consisting of 16 experts from the European Panel for Patient Handling Ergonomics, was also completed for member checking of the evidence found in the field trials.

### Results:

The IET was successful in collecting suitable data for 11/12 sections the financial data was not available at ward level. The IET calculation was used to identify differences in performance between the different locations with mixed success. Improvements for the data collection process were identified in all field trials and will be included in future developments. Some weaknesses were recorded with the musculoskeletal workload measure (Section 10) and the limitations of single point prevalence musculoskeletal health measures were also noted.

### Conclusion:

The IET process was successful in collecting information from field trials in 4 EU countries. The individual IET scores showed differences in performance in 11/12 sections. Improvements in process and format were recorded for further development

The IET performance scores allow an organisation to tailor its intervention strategy to improve specific outcomes. It is designed to be used as a pre-post intervention comparison process but large scale use could develop benchmarking scores to assist in the improvement of patient handling management systems across Europe.

**Keywords:** Health care workers, intervention studies, intervention methods

### References:

- Downs S.H. Black N. (1998). The feasibility of creating a checklist for the assessment of methodological quality of both randomised and non-randomised studies of healthcare interventions. *Journal of Epidemiological Community Health* 52: 377-84.
- Fray M and Hignett S (2009). Measuring the success of patient handling interventions in healthcare across the European Union. *Proceedings of the 17th World Congress on Ergonomics, IEA 2009.*
- Robson L.S., Clarke J.A., Cullen K., Bielecky A., Severin C., Bigelow P.L., Irvin E., Culyer A., Mahood Q. (2007) The effectiveness of occupational safety management system interventions: A systematic review. *Safety Science* 45 (2007) 329-353.



## A STUDY OF SURGEONS' POSTURES AND MUSCLE ACTIVITY DURING OPEN, LAPAROSCOPIC AND ENDOVASCULAR SURGERY

SZETO G.P.Y., CHENG S.W.K., HO P., POON J.T.C., TING A.C.W., TSANG R.C.C.

*Department of Surgery, University of Hong Kong Medical Centre, Queen Mary Hospital, Hong Kong*

### Aims:

Surgeons are a group of health care professionals who are at risk of developing work-related musculoskeletal disorders (WMSD) due to many physical and psychosocial risk factors. High prevalence rates of neck and shoulder pain have been reported among general surgeons (Szeto et al, 2009), and some research on the ergonomic issues faced by surgeons has been reported. Past research has examined electromyography (EMG) in surgeons mainly during simulated conditions of laparoscopic and open surgery but not during real-time operations and not for long durations. Different surgical procedures impose different physical demands on surgeons and the present study aimed to compare the biomechanical loading in surgeons during three different types of surgery. The surgeons' postures and muscle activities were recorded directly in the operating theatre for 30 minutes to over 1 hour.

### Methods:

Twenty five surgeons participated in the study (23 males and 2 females). Surface electromyography (EMG) was recorded in the bilateral cervical erector spinae, upper trapezius and anterior deltoid muscles during 3 types of surgical procedures: open, laparoscopic and endovascular. Kinematics was recorded for the head-neck segment using a biaxial cervical inclinometer and shoulder movements were measured with biaxial electrogoniometers.

### Results:

The present study showed significantly higher cervical muscle activities in open surgery compared to endovascular and laparoscopic procedures. Surgeons generally maintained a flexed neck posture during open surgery and a more extended neck posture during laparoscopic and endovascular procedures. There were trends for greater extents of left shoulder abduction movements in laparoscopic procedures and greater extent of cervical side-to-side movements in open procedures. Open procedures showed trends for higher frequencies of movements generally in most directions. Surgeons reported similar degrees of musculoskeletal symptoms in open and laparoscopic surgeries, which were higher than endovascular surgery.

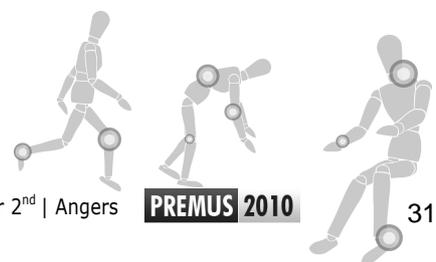
### Conclusion:

The present study showed that open surgery required greater muscle efforts from the cervical and shoulder muscles of the surgeons who had to maintain a flexed neck posture. Laparoscopic and endovascular procedures required the surgeons to maintain their visual focus on the overhead display screen while their arms are kept in static abducted postures in maneuvering laparoscopic instruments. In endovascular surgery the surgeons are required to wear a heavy lead apron throughout the entire procedures, although the manual task demands are fairly light. With the rapidly advancing technology in minimally invasive surgery, these procedures may impose increasing musculoskeletal strains on the surgeons and further investigations are needed.

**Keywords:** Muscle activity, Postures, physical exposure, Health care workers

### Reference:

Szeto GPY, Ho P, Ting ACW, Poon JTC, Cheng SWK, Tsang RCC. 2009. Work-related musculoskeletal symptoms in surgeons. *Journal of Occupational Rehabilitation*, 19: 175-184.



## EVALUATION OF THE BODY GESTURES AND POSTURE CONSTRAINTS AMONG MEDICAL CARE STAFF.

AKROUT M., CHAARI N., GHRAM R., AMRI C., MERCHAOU I., KHALFALLAH T.

*Laboratoire d'Ergonomie, Faculté de Médecine de Monastir, Tunisie*

### **Aims:**

Musculoskeletal symptoms are a common health problem throughout the world. This ergonomic study aimed to assess the biomechanical constraints and working posture among medical care staff.

### **Methods:**

The semi-quantitative analysis of the posture of the medical staff in University Hospital in Monastir (Tunisia) has been achieved making use of the OWAS (Ovaco Working Analysing System).

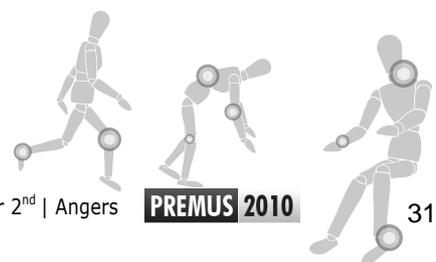
### **Results:**

The data of our study have shown that "back leaning forward" gesture has been observed in the average of 45,2% of the total working time of all medical care workers "twisted back" posture has been noted in 20% of the total time, which accounts for a high prevalence of backaches in the medical field. The starting position "has been noted in 58% of the working time, in fact surgeons and midwives, spend, respectively, 84,1% and 72,3% of their total working time in position in a standing position. The sitting posture has been noted in the average of 13,6% of the total working time of all medical care workers, medical secretaries spend 62% of their working time in a sitting position. An effort of exceeding 10 kg has been noted in only 10% of the total working time of all medical care workers

### **Conclusion:**

A better understanding and improvement of working postures among health care workers is recommended to reduce the prevalence of musculoskeletal disorders.

**Keywords:** Postures, physical exposure, health care workers, exposure measurement methods



## STRATEGIES USED BY PARAMEDICS TO PROTECT THEIR BACK; THE FOCUS ON PREVENTIVE COMPETENCES INVOLVED IN PREHOSPITAL EMERGENCY INTERVENTIONS

ARIAL M., BENOÎT D., WILD P., PICHONNAZ L., DANUSER B.

*Institute for Work and Health*

### **Aims:**

We carried out a research on occupational health in ambulance personnel of the French-speaking part of Switzerland. The study aimed at identifying and better understanding risk factors, as well as strategies that should prevent adverse health outcomes, including back problems.

### **Methods:**

Data collection involved both qualitative and quantitative research methods:

Self-reported questionnaire: we sent a questionnaire to all ambulance personnel employed in the French-speaking part of Switzerland (N = 669). Questions related to the presence, duration and intensity of symptoms were taken from the Standardized Nordic Questionnaire. We also included some questions about functional limitations, working conditions, Effort and Reward Imbalance, and mental health.

Participant observation: We shadowed ambulance personnel for the duration of their entire work shift (in average for one week). Observations took place in eleven services, for a total of 416 hours of observations (including 70 interventions + waiting time). When the situation allowed it, interventions were filmed. Some selected video sequences were used as a support for self-confrontation interviews. Data was analyzed by a multidisciplinary team (ergonomist, psychologist, health and safety specialist).

### **Results:**

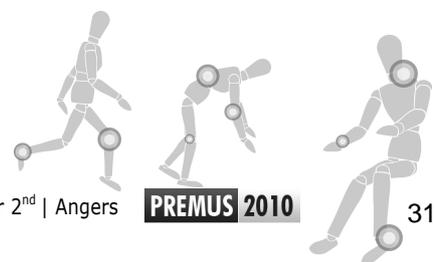
We identified several strategies contributing to limit the exposure to risk factor of back problems. For example, strategies involved postural adaptive behaviors during the intervention (e.g. to lean on the furniture or against the door frame to stabilize the posture while performing delicate manipulation), the participation of the patient, adaptations performed to the “working space” (e.g. moving furniture in order to have the intervention material at an adapted height), cooperation among crew members (e.g. exchange of tasks to allow sufficient recovery time after a particularly strenuous intervention).

### **Conclusion:**

Our presentation will focus on some factors associated to symptoms' presence, intensity, and duration. We will also explain some of the strategies we identified with the qualitative methods.

Kindly supported by the Agence Française de Sécurité Sanitaire de l'Environnement et du Travail (Programme AFSSET-EST-2007-29).

**Keywords:** Postures, Physical exposure, Health care workers, Back, Low back



## THE MUSCULOSKELETAL AND MENTAL DISORDERS IN BRAZILIAN NURSING WORKERS: PROPOSAL FOR ACTION

BAPTISTA P.C.P., FELLI V.E.A., MARTINS A.C.

*University of Saint Paul, Saint Paul, Brazil.*

### **Aims:**

Identify the presence of musculoskeletal and mental disorders in Brazilian nursing workers

Present intervention proposals to workers health

### **Methods:**

This is a quantitative and qualitative intervention study. The present study has scenery seven public and university hospitals, elected in the north, northeast, Midwest, southeast and south of the country according to criterion of representativeness and size (large and extra). In order to capture data of the musculoskeletal and mental disorders has been developed a monitoring system of the nursing workers health (SIMOSTE) that was powered by a responsible institutional setting in periods of four months each. After analysis was proposed a list with health intervention.

### **Results:**

The results showed a total of 340 occurrences of injuries with the workers of the sceneries and 38.82% related to the musculoskeletal system and mental disorders, exemplified by complaints of tendinitis, back pain, stress and depression. Based on the results has been elaborated a list of proposals for action on nursing workers health. The Intervention proposals were review height of benches, acquisition beds with height control device, transfer of patients, provide a fitness center with strength training for muscle relaxation and fitness, reorganization of the work environment, division of labor, staffing, implement break during the workday, provide living area and rest and create moments for discussion about working conditions.

### **Conclusion:**

Among workers it was observed that the musculoskeletal and mental disorders deserve attention, not only related to the handling of patients, materials and furniture, but the forms of work organization, as evidenced by strict supervision and control, denouncing the high incidence of musculoskeletal and mental disorders 1-2-3.

Besides the manipulation of overweight, work standing and inadequate positions, night work and work shift that directly affect the functioning of the body causing headaches, irritability, sleep disturbances and stress, were instances of high prevalence in workers in all sceneries, specially in the Midwest and Northeast Brazil.

Considering that the introduction of strategies and new ways of organizing the work may reflect on the reduction of accidents and diseases, this study aimed to analyze the musculoskeletal and mental disorders in Brazilian nursing workers and propose interventions to improve health.

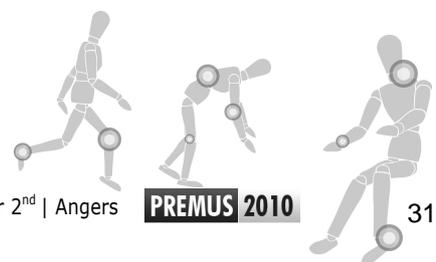
**Keywords:** Musculoskeletal problems, Mental health problems, Workplace intervention

### **References:**

Felli V.E.A. Monitoring of nursing work health: promoting the quality of life in work. Report Final research, 2007.

Leite PC, Merighi MAB, Silva A. The experience of a woman working in nursing suffering from De Quervain's disease. *Revista Lat-Am Enferm* 2007; 15(2): 253-8.

Gurgueira GP, Alexandre NMC, Corrêa Filho HR. Self-reported musculoskeletal symptoms among nursing personnel. *Revista Lat Am enferm* 2003; 11(5):608-13.



## ERGONOMIC STUDY OF MUSCULO-SKELETAL DISORDERS IN MONASTIR HOSPITAL (TUNISIA)

AMRI C., KHALFALLAH T., RASSAS I., CHAARI N., MERCHAOU I., AKROUT M., ADNENE HENCHI M.

*Department of occupational health and safety - Monastir*

### **Aims:**

Musculo-skeletal disorders are a major health problem mainly in health care units. Many methods have been developed in order to assess such risk according to OWAS (Ovaco Working Analyzing System) method.

The aims of our study is to estimate referring to an observational method the charge and the physiological tension on the musculoskeletal system caused by the postural charge and task requirements in health care units.

### **Methods:**

An ergonomic study in the university hospital of Monastir including a representative randomised health care personnel group. This study was established according to OWAS method which is a semi quantitative analysis referring to observation of the risks related to the constraining work postures

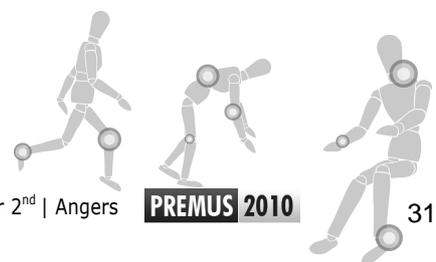
### **Results:**

The painful postures were observed at mean during 18% of the total work duration. Among all professional categories, the “back leant ahead” posture was observed at mean during 45.2% of the total work duration. The “twisted back” posture was observed during 20% of time. The upright posture represents almost half of global duration mainly among surgeons (84.1%) and midwives (72.3%). A handling activity exceeding 10 kg was observed in 10% of total work duration among healthcare personnel

### **Conclusion:**

The major constraints in a health care environment are the unfavourable handling and postures. The back pain are a frequent complaint. Methodology used allowed us to identify and to quantify risks related to the constraining postures of the work station. Results were given in the global scale and by physical zone (back, arm, legs). However, this method is not applicable for the wrists and does not approach other risk factors such as the repetitiveness and the time of preservation of a physical activity. The musculo-skeletal disorders prevention is complex because of a multifactorial origin. It should include a screening step allowing the detection of possible risk factors followed by an interventional step which is an ergonomic approach aiming the adaptation of the work to man.

**Keywords:** Exposure measurement methods, intervention studies, intervention methods



## VALIDATION AND ADAPTATION OF A QUESTIONNAIRE TO IDENTIFY MUSCULOSKELETAL SYMPTOMS LINKED TO WORK.

CHEVEREZ-RODRIGUEZ N.E., ORTA-ANÉS L., ELÍAS-BONETA A., VELEZ-SANTORI C.N.

*Medical Sciences Campus of University of Puerto Rico, Puerto Rico*

### **Aims:**

To establish content validity for the survey regarding Muscle-skeletal disorders among Puerto Rican dentists.

To identify if dentists consider the questionnaire an effective data collection instrument relevant to dentist's occupational health

To identify which method (regular or e-mail), is the best to use when distributing the surveys.

### **Methods:**

The questionnaire was adapted from one created and used in a national survey with dentists conducted in 2006 by University of British Columbia, Canada researchers (Rucker, L.M., et al 2006). We obtained the authors authorization to use and adapt the instrument. Parts of this instrument were adapted but the overall presentation changed from illustrations to photos depicting students performing real tasks. The pilot questionnaire was sent by e-mail to 14 dentists with some discussion to guide in the analysis and improvement of the instrument.

### **Results:**

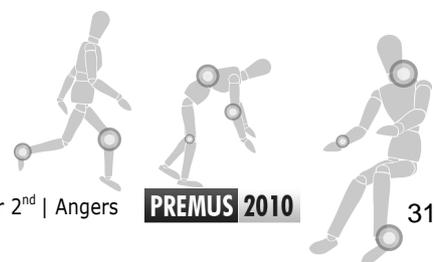
12 of 14 questionnaires sent out were completed and returned. The average time to answer it was between 20-30 minutes. The consensus among respondents was that they preferred to receive the survey by internet rather than regular mail. All of them were positively impressed by the use of photos for the illustration of postures and mentioned it was an asset of the instrument. A couple of items were mentioned to be confusing and issues that were recommended to us were added. All surveyed dentists mentioned their support to the study and told us the desire of participate in it. It is important to recognize the tight collaboration of Colegio de Cirujanos Dentistas de PR(CCDPR), (Organization that regulates the practice of Dentistry in PR). Qualitative technique was performed to do analysis of this process. Data of proposed national study with Puerto Rican dentists is expected to be collected by summer of 2010.

**Keywords:** Postures, physical exposure, health care workers, exposure measurement methods

### **References:**

Bravo, M. Rubio, Canino, G. (1993). The Spanish translation and cultural adaptation of the diagnostic interview schedule for children (DISC) in Puerto Rico Culture, medicine and Psychiatry 17: 329-344, 1993

Rucker, L. M. & Sunell, S. (2006). Ergonomics Health Promotion for B.C. Dental Offices. (Final Report) <http://www.worksafebc.com>



## CHANGES IN ERGONOMIC EXPOSURES OF NURSING ASSISTANTS FOLLOWING A NO-LIFT PROGRAM IN NURSING HOMES

KUROWSKI A., BOYER J., FULMER S., PUNNETT L.

*Dept. of Work Environment, Univ. Massachusetts Lowell, USA*

### **Aims:**

Musculoskeletal disorders are associated with physical work demands such as manual resident handling in nursing homes. In 2005, a large nursing home corporation began implementing a “No-Lift Program” (NLP) in all of its facilities. This involved installation of resident handling equipment along with procedures and policies for staff training and equipment maintenance. Our objective was to investigate the effect of the NLP on ergonomic exposures through direct observations of manual handling activities, resident handling activities, and equipment use.

### **Methods:**

Ergonomic exposures of nursing assistants were documented using PATH (Postures, Activities, Tools, and Handling)<sup>1</sup>. This method for analyzing non-cyclical work was modified to add resident handling activities and specific types of equipment. In seven nursing homes, we collected data on 295 workers at baseline (51 workers), 3-months (56 workers), 12-months (100 workers), and 24-months (88 workers). PATH variables of ‘trunk angle,’ ‘leg action,’ ‘arm angle,’ ‘weight in hands,’ ‘resident handling type,’ and ‘resident handling equipment’ were compared between baseline and follow-up periods, using weighted frequencies (SAS 9.1).

### **Results:**

Two years after NLP implementation, the proportion of time that nursing assistants were handling residents dropped from 13.3% to 8.9%. While resident handling, nursing assistants used lifting equipment 19.4% of the time vs. 9.9% before the NLP, and neutral trunk postures were 23.7% more frequent than before. Nursing assistants were observed working with fewer flexed, laterally bent or twisted trunk postures; less static standing and more dynamic leg action; and more often with both arms below 60 degrees. Loads heavier than 50 pounds were handled less frequently and loads lighter than 10 pounds more frequently.

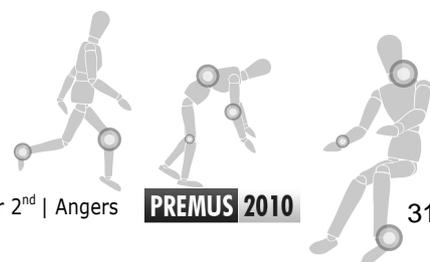
### **Conclusion:**

Changes in observed ergonomic exposures indicate that the NLP was effective in reducing the amount of time nursing assistants spend in resident handling, the weights they handle, and their body postures during resident handling. This in turn means lower loading on the musculoskeletal system, including the lumbar spine, shoulders and knees. In parallel, preliminary analyses of injury rates and workers’ compensation claims suggest that these reduced exposures were accompanied by health benefits from the increased use of resident handling equipment.

**Keywords:** Postures, physical exposure, health care workers, intervention studies

### **Reference:**

[1] Buchholz, B., Paquet, V., Punnett, L., Lee, D. and Moir, S., 1996. PATH: A work sampling-based approach to ergonomic job analysis for construction and other non-repetitive work, *Applied Ergonomics*, 27, 177-187.



## PREDICTORS FOR EFFECTIVE PREVENTION OF LOW BACK PAIN IN NURSES

MICHAELIS M., HERMANN S.

Freiburg Research Center for Occupational and Social Medicine (FFAS), Freiburg, Germany

### Aims:

Using a control group-based cross-sectional evaluation design the multi-dimensional training program Back Protective Patient Transfer (BPPT) were analyzed to find out criteria for successful implementation and effects on several outcomes (back health, work load). "Instructors" are trained to teach their colleagues on the wards, to give practical support and refresher courses with the aim to generate sustainability. Patient transfers are planned using team structures with special regard to ergonomic devices and work place adjustment related to the specific transfer situations.

### Methods:

The questionnaire investigation took place in 2008 (19 German hospitals, 3 nursing homes), measuring prevalence rates of musculoskeletal disorders. Predictor variables of a) the program to ensure the sustainability of effects and b) factors of individual implementation in the intervention group (n=249) were estimated by bi- and multivariate logistic and linear regression (forward elimination, p

### Results:

The most dominant predictors in the multivariate analysis are shown in table 1. This mainly applies to competencies in the use of BPPT-principles and of ergonomic equipment, aspects of sustainability (refresher courses) and work organization. Especially the personal support plays an important role for BPPT-application. RRR and RBI values range from one to two thirds related to prevalence rates of back pain. At least two thirds can be attributed to most frequent application of BPPT-principles regarding perceived reduction of physical work load and improvement of back health. The predictor "application" itself correlates strongly with personal support factors.

Outcome (total preval./ index value)	Predictor(s)	Outcome value			RRR/ RBI (%)
		1 (min)	2 (max)	3 (add)	
Low back pain, all symptoms, one- year-prevalence (72,0%)	Favorable work organization related to patient transfers (sum index 0-1)	91,0%	64,7%		RRR <sub>(Out 1-2)</sub> =28,9
	Additionally: experience with refreshing courses			47,6%	RRR <sub>(Out 2-3)</sub> =26,4
	<i>Difference Out1 – Out3</i>				RRR <sub>(Out 1-3)</sub> =47,7
Sciatic symptoms, one-year- prevalence (32,9%)	Use of available devices (sum index 0-1)	69,2%	37,8%		RRR <sub>(Out 1-2)</sub> =45,4
	Additionally: satisfaction with support of instructors			22,5%	RRR <sub>(Out 2-3)</sub> =40,5
	<i>Difference Out1 – Out3</i>				RRR <sub>(Out 1-3)</sub> =67,5
Reduced physical load (46,4%)	Application frequency of BPPT-principles (sum index 0-1)	20,0%	63,3%		RBI <sub>(Out 1-2)</sub> =68,4
Back health improved (45,8%)	Application frequency of BPPT-principles	13,6%	67,2%		RBI <sub>(Out 1-2)</sub> =79,8
Frequent application of BPPT-principles (Index value 0,66) *	Satisfaction with support of instructors	0,49	0,51		RBI <sub>(Out 1-2)</sub> = 3,9
	Additionally: with support of nursing management			0,71	RBI <sub>(Out 2-3)</sub> =28,2
	<i>Difference Out1 – Out3</i>				RBI <sub>(Out 1-3)</sub> =31,0

Legend

Out<sub>(min)</sub> = Minimal influence measured in outcome variable, Out<sub>(max)</sub> = Maximum influence measured in outcome variable,

Out<sub>(add)</sub> = Outcome value while occurrence of the additional predictor.

RRR= relative Risk reduction, RBI= relative benefit increase compared to reference value of the outcome. \* = only bivariat analysis

Table 1: Effect sizes of intervention and BPPT-application predictors for different outcomes

### Conclusion:

The analysis demonstrates that the comparison of prevalence rates between intervention- and control group is not sufficient to estimate effects. Also the degree of the development of a "preventive culture" in the intervention group should be controlled for final as well as for intermediate outcomes.

**Keywords:** Health care workers, Early prevention, Prognosis of MSD

### Reference:

Michaelis S, Hermann S. Evaluation of the nursing concept „Back protecting patient transfer“. Research report F 2196, Federal Institute for Occupational Safety and Health (BAuA) 2010. In press (January 2010)



## USING A WORK SYSTEMS ANALYSIS TO REDESIGN COMPUTER TASK EXPOSURES IN RADIOLOGISTS

ROBERTSON M.M., CHANG J.C., DAINOFF M., GARABET A., DENNERLEIN J.T.

*Liberty Mutual Research Institute, USA*

### **Aims:**

Prolonged computer pointing device use by radiologists and their high prevalence (recently reported as 58%) of upper extremity MSD's indicates a need for interventions. The overall goal of this study is to reduce radiologists' awkward postures associated with the prolong use of the computer mouse while using picture archiving software when reviewing cases. As a first step, we performed a cognitive work analysis, describing the process and approaches to redesigning the radiologists' tasks with the goal of reducing the postural load.

### **Methods:**

We used a cognitive work analysis, based on Vicente's (1999) framework of computer-based work in complex socio-technical systems. This approach considers the physical and external environment and the effects of these imposed constraints. Two major steps were conducted: Work Domain Analysis and Mapping of the Operation Requirements. We videotaped and interviewed 6 knowledgeable radiologists performing their task. A steering committee consisting of 2 senior and 1 fellow radiologist assisted in the redesign activity. Through, a participatory ergonomics approach involving the committees ideas and testing different options we reassigned many of the main functions to a new device and configuration. Training and practice sessions were designed on setup and use of the device and workstation layout.

### **Results:**

The majority of tasks were performed with complex and prolonged pointing device activities. The pointing device activities were grouped into two basic physical functions, image manipulation (e.g. zoom) and image measurement tools (e.g. distance). These functions each had several physical functions that included activation of either keyboard keys or specific icons located in tool bars. The reassignment of these activities involved mapping the keyboard and iconic functions to an input device with a scroll wheel and numerous programmable keys as a substitute for the main keyboard and many of the mouse functions. Almost all of the functions can be completed exclusively with the alternative input device and the mouse. Since the keyboard is needed minimally, now it can be pushed back away from the user allowing a central positioning of these two devices immediately in front of the user, thus reducing the need for individuals to externally rotate their shoulders. Preliminary observations revealed more comfortable use with no loss in performance functionality.

### **Conclusion:**

In conclusion, using cognitive work analysis in conjunction with participatory ergonomics, we were able to achieve a more posture neutral input device configuration with equal if not better usability.

**Keywords:** Postures, physical exposure, computer work, health care workers

### **Reference:**

Vicente K.J.,. Cognitive work analysis: Toward safe, productive, and healthy computer-based work. Lawrence Erlbaum Associates, New Jersey. 1999



## **WORK DEMANDS, CONSTRAINTS AND MUSCULOSKELETAL IMPACTS AMONG DISHING CLEANING WORKERS OF A CARDIOLOGIC HOSPITAL IN SÃO PAULO, BRAZIL.**

ROCHA L.E., GLINA D.M.R., SIQUEIRA A.R., ISOSAKI M.

*School of Medicine University of São Paulo- LIM-40, Brazil*

### **Aims:**

Identify work demands and constraints in nutrition attendants' activity in the dish cleaning and describe musculoskeletal impacts.

### **Methods:**

A case study took place in the Food Production Section of a cardiologic hospital food service located in São Paulo, with 12 nutrition attendants. Ergonomics Work Analysis was performed and included global observations for 30 hours and systematic observations for 72 hours and visual documentation of the work and interviews. Measures of noise, illumination, temperature, height of working surfaces and devices and weight were taken. Clinical exams were performed.

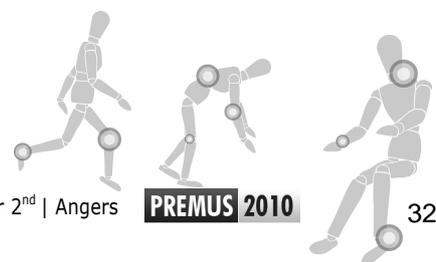
### **Results:**

64% males, 71% between 25 and 44 years, 64% with high school level, 57% married, 92% had children. This kitchen worked 24 hours a day. Shifts of 12 hour duration, with one hour break for lunch, and 30 minutes coffee break. Food production section provides 3500 meals daily. 1420 trays and dishes were cleaned 3 times a day. At the intervals the employees needed to help at the food distribution assembly line. Workstations were: unloading pushcarts; pre washing; feeding the dishwasher; take out the dishes from the machine and organization in piles; drying and setting in order the trays. Physical demands were: excessive work volume; absence of rest breaks; long hours on standing posture; short work cycles; adoption of extreme postures; physical effort; excessive number of movements and constant displacements. Cognitive demands were: maintenance of high quality; monotonous work; need of concentrated and distributed attention; visual perception and discrimination of details; polyvalence, flexibility and need of constant decision making. Emotional demands were: cooperation with superiors and colleagues; lack of control; adaptation to different forms of work division and superiors; lack of motivation and acknowledgement. Main constraints were: reduced working space, shared with employees from other sections; disorganized layout; irregular, damaged and slippery floor with rests of food; deficient illumination; inadequate furniture, equipments, trolleys, and instruments; glass dishes; utensils weight; height of working surfaces; insufficient number of employees, high absenteeism; fast rhythm and time pressure. All employees referred musculoskeletal symptoms. Physical exams identified shoulder depression; reduction of manual dexterity and muscle strength.

### **Conclusion:**

This study verified the presence of important physical, cognitive and psychic demands with constraints related to space and layout, work environment, equipments, work surfaces, organizational and psychosocial aspects, which generated impacts on musculoskeletal system. Project granted by FAPESP – No 5/56541-3.

**Keywords:** Biomechanics, health care workers, exposure measurement methods



## FATIGUE INDUCED LOADING ON THE LUMBAR SPINE: AN INVESTIGATION OF INTRA-SHIFT VARIATION IN MANUAL HANDLING PERFORMANCE AMONGST PHYSIOTHERAPISTS

ROTHMORE P., HEWITT A., NGUYEN T., GUNN S.

*The University of Adelaide, Adelaide, Australia & Repatriation General Hospital, Adelaide, Australia*

### Aims:

Despite evidence of the association between work-related risk factors and musculoskeletal disorders, manual handling injuries in the health-care sector are disturbingly common. A previous study of manual handling injuries in South Australian hospitals identified that 41% of injuries occurred in the last quartile of the shift (Rothmore et al 2000). This paper will examine two hypotheses for this “last quartile effect”. Firstly, that manual handling performance during a shift is influenced by within-shift changes in muscle tone and supporting structures placing staff at risk of injury, irrespective of prior training or knowledge of safe work practices. Secondly, that muscle fatigue and other factors may lead to staff performing manual handling tasks in an energy saving, but more hazardous manner, at the end of a shift.

### Methods:

This study used inverse dynamics modelling to determine the three-dimensional loading forces on the lumbar spine in 40 physiotherapists during the performance of two standard manual handling tasks (one dynamic and one static) pre and post-shift. Trunk and hip kinematics variables were measured and used to calculate the compression and two shear forces (A-P and lateral) acting at L5/S1. Electromyography analyses were undertaken to quantify the median power frequency and mean integrated amplitude and to document neurophysiological fatigue of the measured muscles. Participants also rated their overall subjective level of fatigue and pain/discomfort during task performance using a visual analogue scale.

### Results:

Preliminary results have shown that for the dynamic task there were significant differences ( $p < 0.05$ ) in compression (both pre and post-shift) and in anterior shear force (post-shift) between lifting and lowering phases. EMG analysis showed a trend towards significance (pre and post-shift) in activation of the lumbar extensors during the lowering phase ( $p = 0.06$ ). When data for lifting and lowering phases were combined there were significant differences in anterior shear ( $p < 0.05$ ) and lumbar extensor activation pre and post-shift. During performance of the static task there were significant differences ( $p < 0.05$ ) in the activation of the lumbar extensors and quadriceps (pre and post-shift) and in self-reported pain. Significant differences were found (pre and post-shift) in self-reported levels of fatigue.

### Conclusion:

This study has demonstrated that not only do significant differences exist between lifting and lowering tasks but that there are significant differences between pre and post-shift task performance even among experienced manual handlers operating under ideal conditions. Further consideration needs to be given to the temporal nature of physiological changes in injury prevention.

**Keywords:** Biomechanics, Postures, Physical exposure, Health care workers

### Reference:

Rothmore P., Elix G., Ben-Tovim D., Messenger H., Pearce S. and Hakenforf P. 2000. A study of manual handling injury among nurses in Divisions of Medicine at two teaching hospitals, In D. Worth (Ed.) *Moving in on Occupational Injury*. (Butterworth-Heinemann), 275-285



## MUSCULOSKELETAL INJURIES AMONG HOSPITAL PATIENT CARE STAFF BEFORE AND AFTER IMPLEMENTATION OF PATIENT LIFT AND TRANSFER EQUIPMENT

SCHOENFISCH A.L., MYERS D.J., POMPEII L.A., DEMENT J.M., LIPSCOMB H.J.

*Duke University, Durham, North Carolina, USA*

### **Aims:**

Interventions such as "minimal-lift" policies and patient lift/transfer equipment are often employed to prevent musculoskeletal disorders and injuries associated with patient handling. We evaluated the effectiveness of an intervention on musculoskeletal injury and disorder rates and associated lost and restricted workdays among patient care staff at a medical center and affiliated community hospital over an 11-year period. Patient lift and transfer equipment was implemented in a staggered fashion on patient care units in line with a policy shift to a "minimal-manual lift environment."

### **Methods:**

Workers' compensation (WC) claims data from 1997 through 2007 provided reported musculoskeletal injuries and disorders (MSDs) among patient caregivers, lost and restricted workdays associated with MSDs, and whether MSDs were attributed to patient-handling. Human resources data, individually-linked to WC data, provided worker characteristics and full-time equivalents for the calculation of injury rates. MSD rates, post- versus pre-intervention rate ratios (IRR) adjusted for worker age, job title and hospital, and 95% confidence intervals (CI) were calculated using Poisson regression. Latency of the interventions' effects was assessed using a pre-post evaluation, lagging by 6-month windows.

### **Results:**

During the 11-year period, 1761 MSDs were reported through WC by patient caregivers at the two hospitals. Three-quarters of these MSDs (n=1288,73.1%) were attributed to patient-handling, of which 10% had associated lost workdays and 40% had restricted workdays. The policy change was marked by a decline in the rate of patient-handling MSDs [adjusted IRR 0.79, 95%CI (0.70,0.90)], particularly those with lost or restricted workdays. Implementation of the lift equipment was not marked by a similar change in patient-handling MSD rate [adjusted IRR 1.01, 95%CI (0.86,1.18)]; however, the rate of patient-handling MSDs with lost workdays declined 65%.

### **Conclusion:**

Abrupt declines in patient-handling MSDs and lost and restricted workday rates among patient caregivers were observed following implementation of a "minimal manual lift environment" policy. Although lift equipment may have aided in sustaining observed declines, the data likely reflect broader institutional change. Of significance, the time of the policy change was marked by a shift of WC claim and lost workday fiscal responsibility from the health care system to nursing unit managers and a requirement to report work-related injuries within 24 hours. In addition to statistical analyses, intervention effectiveness evaluations should consider contextual detail surrounding intervention implementation and outcome measures of interest.

**Keywords:** Health care workers, Epidemiology, Intervention methods



## VALIDITY AND RELIABILITY OF THE “JOB FACTORS QUESTIONNAIRE” FOR PHYSICAL THERAPIST TASKS

SHIMABUKURO V.G.P., ALEXANDRE N.M.C.

*Department of Nursing, Faculty of Medical Sciences, University of Campinas – UNICAMP*

### **Aims:**

The purpose of this study was to adapt an instrument to evaluate physical therapists' perception of work-related factors that may contribute to musculoskeletal symptoms, and to assess its psychometric properties.

### **Methods:**

Initially, a broad literature review was performed in order to adapt and to develop the items of the questionnaire. Afterwards, a panel with 10 experts revised its content, and a pre-test was performed with 11 physical therapists. Then, was self-administrated in 142 physiotherapists and psychometric properties were evaluated. The reliability was verified by measuring the temporal stability through a test-retest design, and the internal consistency was assessed by Cronbach's alpha coefficient. Construct validity was tested using the known-groups technique, comparing the physiotherapists responses with the answers obtained from a group of administrative workers.

### **Results:**

The expert panel suggested modifications in the instruction and 10 items of the questionnaire. The instrument was reduced from 17 to 16 items. The scale that firstly ranged from 0 to 10 had an extra option NA (not applicable) included. The test-retest indicated a Intra-class Correlation Coefficient (ICC) of 0.80-0.90 ( $p < 0.001$ ; 95%CI 0.75-0.93). Cronbach's alpha coefficient was 0.91 for physical therapists and 0.87 for administrative workers. Construct validity demonstrated a statistically significant difference in both groups.

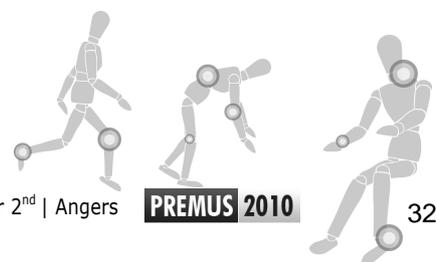
### **Conclusion:**

This study showed evidence of content validity, reliability (stability and internal consistency) and construct validity of the “Work related activities that may contribute to job-related pain and/or injury among physical therapists”, pointing this instrument as a useful tool for the researches involving this issue.

**Keywords:** Health care workers, Personal risk factors for MSD

### **References:**

Rosecrance JC, Cook TM, Zimmermann CL. Test-retest reability of a self-administered musculoskeletal symptoms and job factors questionnaire used in ergonomics research. *Appl Occup Environ Hyg.* 2002; 17(9): 613-21.  
Coluci MZO, Alexandre NMC. Cross-cultural adaptation of an instrument to measure work-related activities that may contribute to osteomuscular symptoms. *Acta Paul Enferm* 2009; 22(2): 149-54.



## DEVELOPMENT OF AN OBSERVATIONAL WALKTHROUGH CHECKLIST USED TO EVALUATE HOSPITAL WORKER SAFETY WITHIN A PATIENT CARE UNIT

UDTAMADILOK T.<sup>1</sup>, BRUNO J.L.<sup>1</sup>, O'DAY E.<sup>2</sup>, HOPCIA K.<sup>1,2</sup>, DENNERLEIN J.T.<sup>1</sup>

<sup>1</sup> Harvard School of Public Health, Boston, MASSACHUSETTS, USA - <sup>2</sup> Partners HealthCare, Boston, MASSACHUSETTS, USA

### Aims:

Although several tools exist for evaluating postural risk factors in the workplace [1,2], these tools focus primarily upon tasks performed by the worker rather than the environment surrounding the worker. In the patient care environment, there is need for a comprehensive observational tool that focuses strictly on the physical factors of the work environment that contribute to musculoskeletal disorders and acute injury. The goals of this study were to develop and test an observational checklist that can evaluate and inform environmental interventions about health care worker safety in a patient care unit (PCU).

### Methods:

The checklist has evolved through multiple revisions. First, we convened a team of experts to determine environmental sources of injury in the PCU, listing as many items as possible. We then performed qualitative walkthroughs through a wide variety of PCUs that included discussions with nursing staff on each unit. A first draft was compiled from these two activities. Each subsequent draft has been vetted with experts and walkthrough evaluations.

### Results:

The items in the checklist are structured around the organization of PCUs and the potential sources of injury being studied (Table). Walkthroughs identified four common operational areas across PCUs, and consultation with experts informed our four categories for potential sources of injury.

**Table: Breakdown of checklist items by area and potential sources of injury**

Operational Area	Sources of Injury			
	Non-neutral postures	Excessive lifting, pushing, pulling	Slips, trips, falls	Collisions
Patient Rooms	11	10	3	1
General Environment	1	2	2	5
Nurse Workstations	3		1	
Storage Facilities	5	1	1	1

### Conclusion:

The resulting checklist provides a simple and comprehensive walkthrough tool that can be used by researchers (to quantify general work environment conditions), PCU unit personnel (to control for potential hazards in a unit as part of a continuous improvement process), and occupational health professionals (to assess current practices). The checklist will be modified based on testing for construct validity and predictive validity.

**Keywords:** Postures, physical exposure, Health care workers, Intervention methods.

### References:

- 1 Buchholz B, Paquet V, Punnett L, Lee D, Moir S. PATH: a work sampling-based approach to ergonomic job analysis for construction and other non-repetitive work. *Appl Ergon.* 1996;27(3):177-87.
- 2 McAtamney, L., Corlett, E.N. RULA: a survey method for the investigation of work related upper limb disorders. *Appl. Ergon.* 1993;24(2):91-99.



## MUSCULOSKELETAL DISORDERS IN SPECIFIC SECTORS

### PHYSICAL WORKLOAD IN DIFFERENT WORK TASKS IN FEMALE GROCERY STORE WORKERS

BALOGH I., OHLSSON K., HANSSON G.Å.; NORDANDER C.

*Division of Occupational and Environmental Medicine, University Hospital, SE-221 85 Lund, Sweden*

#### Aims:

In a survey 2003 from Statistics Sweden 93% of the cashiers in grocery stores reported physically monotonous repetitive work, at least half the time. Recent recommendations from Work Environment Authorities state: if the checkout work is repetitive and closely controlled, it must be organised so, that it normally not exceeds 4 hours/day and not lasts for more than 2 hours at a time. These demands require changes in how the work is organised. Consequently, information about the physical workload in all work tasks is essential. The aim was to quantify the physical workload, psychosocial factors and musculoskeletal disorders.

#### Methods:

In an ongoing study, about 1600 females answered a postal questionnaire regarding personal factors, work tasks, musculoskeletal complaints and psychosocial factors. On 308 of these, a physical examination was performed (1). Further, direct technical measurements (2, 3) were applied on 27 subjects; “checkout work” (N=22), “filling up the shelves” (N=17), “manual attending customers with provisions” (N=5) and “supervision of self-scanning” (N=5).

#### Results:

The mean age was 42 years and the mean employment time 12 years. The prevalence of subjective complaints in neck/shoulders during the last 7 days was 56% and 31% received at least one diagnosis in this region. Corresponding figures for elbows/hands were 42% and 9%, respectively. Preliminary results show large differences in workload between the tasks. “Filling up the shelves” required high muscular loads for both the trapezius and the forearm extensors (90th percentile: 20% and 35% of maximal EMG, respectively), highly elevated arms (99th percentile: 107°), as well as high velocities for head, arms and hands. Contrary “supervision of self-scanning” implied low loads in all aspects. Despite more physical demanding, “filling up the shelves” implied more dynamic work e.g. larger variations in work postures. As to the psychosocial work situation, as many as 80% reported low control and 40% a combination of high demands and low control i.e. high work strain.

#### Conclusion:

The musculoskeletal disorders as well as the physical workload for “filling up the shelves” are comparable with force demanding repetitive industrial work. Introduction of new technology, e.g. customer self-scanning, provides new tasks with a low physical load. This, in combination with a balanced work rotation, can provide a more varied load, which might reduce the high prevalence of musculoskeletal disorders among female cashiers.

**Keywords:** Muscle activity, Postures, physical exposure, Work organization

#### References:

Nordander C, Ohlsson K, Åkesson I, Arvidsson I, Balogh I, Hansson GÅ, Strömberg U, Rittner R, Skerfving S. Risk of musculoskeletal disorders among females and males in repetitive/constrained work. *Ergonomics* 2009;10:1226-1239.  
Hansson G-Å, Balogh I, Ohlsson K, Granqvist L, Nordander C, Arvidsson I, Åkesson I, Unge J, Rittner R, Strömberg U, Skerfving S. Physical workload in various types of work; part I: wrist and forearm. *Int J Ind Ergon* 2009;39:221-233. doi:10.1016/j.ergon.2008.04.003  
Hansson G-Å, Balogh I, Ohlsson K, Granqvist L, Nordander C, Arvidsson I, Åkesson I, Unge J, Rittner R, Strömberg U, Skerfving S. Physical workload in various types of work: Part II. Neck, shoulder and upper arm, *International Journal of Industrial Ergonomics* (2009), doi:10.1016/j.ergon.2009.11.002



## FULL-SHIFT UPPER EXTREMITY DIRECT EXPOSURE ASSESSMENT AMONG US DAIRY PARLOR WORKERS

DOUPHRATE D.I., ROSECRANCE J.C., FETHKE N.B., NONNENMANN M.W.

Colorado State University, Fort Collins, Colorado, USA

### Aims:

Dairy workers in the US have the second highest prevalence of agriculture injuries. Over 80% of dairy workers have musculoskeletal symptoms (MSS), with milking and feeding tasks being the most demanding. Dairy production in the US has steadily moved toward large-herd industrialized parlor operations because of associated economies of scale. To date, no research efforts have characterized or compared workplace risk factors as they relate to worker injury in these large-herd parlor operations. A need exists for more focused research that investigates US milking practices and parlor designs as they relate to worker safety and health. Specific aims of this research project were to quantify upper extremity exposure to postural load and muscle force in large-herd milking parlors.

### Methods:

Dairy parlor workers were recruited from dairy operations with a minimum milking herd of 2,000 head. Full-shift (minimum 8 hours) electromyographic activity (EMG) was recorded unilaterally (dominant arm) from the anterior deltoid, upper trapezius, flexor digitorum superficialis (flexor forearm) and the extensor digitorum (extensor forearm). In addition, full-shift shoulder posture activity was recorded bilaterally using inclinometry technology affixed to the upper arm. Amplitude Probability Distribution Function (APDF) and Exposure Variation Analysis (EVA) were used to statistically analyze upper extremity exposure to postural load and muscle force.

### Results:

Full-shift EMG APDF results revealed mean peak loads of 57.8% of Maximum Voluntary Contraction (MVC) of the flexor forearm musculature and 48.5% of MVC of the anterior deltoid. Full-shift EVA results revealed 94% of myoelectric activity in both flexor forearm and anterior deltoid musculature was 1 second or less in duration, indicative of highly repetitive activities. Full-shift shoulder posture EVA revealed nearly 40% of the workshift involved the shoulder being elevated greater than 45 degrees.

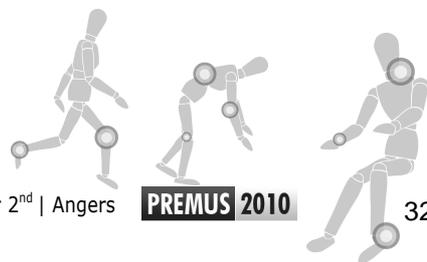
### Conclusion:

Based on studies of muscular endurance during constrained static and dynamic work, Jonsson recommends muscle contraction force peak loads should not exceed 50% of MVC to reduce risk for muscular injury. Silverstein reported upper arm flexion  $\geq 45$  degrees  $\geq 15\%$  of time combined with forceful exertions or forceful pinch to be a significant risk factor for development of Rotator Cuff Syndrome. Our preliminary findings revealed large-herd parlor workers may be exposed to upper extremity risk factors (extreme posture, repetition, high muscle loads) associated with the development of musculoskeletal disorders. Continued ergonomic research is needed to further quantify these exposures to facilitate the development of cost-effective ergonomic interventions.

**Keywords:** Muscle activity, Postures, physical exposure, Agriculture

### References:

- Douphrate D, Nonnenmann M, and Rosecrance J. Ergonomics in industrialized dairy operations. *J of Agromedicine*. 2009;14:406-412.  
Jonsson B. Measurement and evaluation of local muscular strain in the shoulder during constrained work. *J Human Ergol*. 1982;11:73-88.  
Silverstein B, Bao S, Fan Z, Howard N, Smith C, Spielholz P, et al. Rotator cuff syndrome: personal, work-related psychosocial and physical load factors. *J Occup Environ Med*. 2008;50:1062-1076.



## COMPRESSION AND SHEAR FORCES OF THE LOWER BACK IN CABIN ATTENDANTS DURING PUSHING AND PULLING OF MEAL CARTS

SANDFELD J., ROSGAARD C., JENSEN B.R.

Laboratory of Motor Control and Biomechanics, Department of Exercise and Sports Science, University of Copenhagen, Denmark.

### Aims:

Pushing and pulling increases risk of low back pain and is related to the working situation and body position (Hoozemans et al. 1998). The aim was to assess the acute compression and shear forces at the L4-L5 level during simulated working situations and to identify which working situations produced the highest strain. Also, two different floor types were tested.

### Methods:

In a setup 17 cabin attendants (10 females (42.5±8.2 yrs), 7 males (37.3±10.2 yrs)) pushed and pulled a standard meal/drink cart (1m×0.3m×0.5m, 60 kg) on 2 different surfaces (carpet and linoleum) and 3 floor inclinations (-2°, 0° and +2° degrees). 2D movement analysis was performed: Video (50Hz) and force (1000Hz). Two force transducers (KIS2, Vishay Nobel AB, Sweden) were used as handles. 4D WATBAK modelling tool (University of Waterloo, CA) was used to calculate the acute load based on the body posture and peak external forces on the hands.

### Results:

Main significant results showed a 37% higher compression force during pulling (909N) compared to pushing (663N). During pulling, compression and shear force increased with increased inclination by 11.3% and 9.6%, respectively. Linoleum reduced compression force during pushing and pulling by 7.9% and 3.7%, respectively and shear force during pulling by 15.9%. During pulling, compression force correlated highly with and increased markedly with increasing handle force (Slope of regression:  $y=3.8x+597N$ ,  $r^2=0.97$ ). Also, shear force correlated highly with handle force ( $y=1.65x-36N$ ,  $r^2=0.94$ ) during pulling.

Table 1:

Results of 12 working situations. Subjects completed 3 trials of each of the 12 working situations. Inclination values are mean of 2 surfaces and surface values are mean of 3 inclinations

Condition	Compression forces (Means ±SD)		Shear forces (Means ±SD) (Positive values: anterior force direction)	
	Push (N)	Pull (N)	Push (N)	Pull (N)
-2°	633 ±261	858 ±213	-44.3 ±38.7	81.0 ±44.6
0°	681 ±273	915 ±212	-41.4 ±54.2	97.1 ±47.3
+2°	675 ±288	966 ±190	-38.2 ±86.3	123.1 ±62.0
Carpet	691 ±294	927 ±205	-46.2 ±51.5	109.1 ±56.6
Linoleum	635 ±255	892 ±205	-36.4 ±67.9	91.7 ±46.0

### Conclusion:

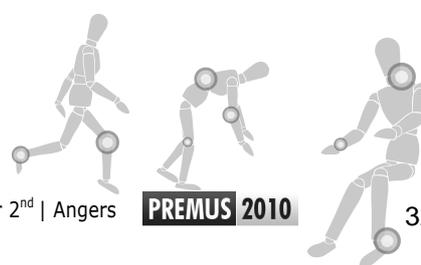
Recommendations: Cabin attendants should avoid pulling when possible and should serve customers pushing downhill. Linoleum floors decrease low back load but especially, slow cart accelerations keeping handle force down will decrease low back compression and shear forces.

The project was supported by SAS Scandinavian Airlines and SAS Cabin Attendants Union

**Keywords:** Biomechanics, Postures, physical exposure, Back, low back

### Reference:

Hoozemans, MJM et al. Pushing and pulling in relation to musculoskeletal disorders: a review of risk factors. *Ergonomics*. 1998;41(6):757-781



## HEALTH RISKS OF AFRICAN AND LATIN DRUMMING: INSTRUMENT SPECIFIC INJURIES OF THE UPPER EXTREMITIES IN HAND DRUM PLAYERS

GARRABE H.

*Santé au Travail 72, Le Mans, France*

### Aims:

Percussionists who play African and Latin drums are obviously exposed to excessive sound levels and often have to perform outside and carry drums when marching. Our purpose is to attract attention on the fact that they are also at risk of musculoskeletal and dermatological disorders of the upper extremities.

### Methods:

We focused on musicians who play either West African or Cuban drums. We began by observing the different instruments, instrumental techniques and types of strokes. We then used interviews and questionnaires to review the musicians' medical complaints. Our study population included 24 percussionists who teach, perform and rehearse in our area (including 5 amateur musicians who play for 4 hours a week or more), plus 6 African born percussionists (interview only) who had come to give concerts or masterclasses.

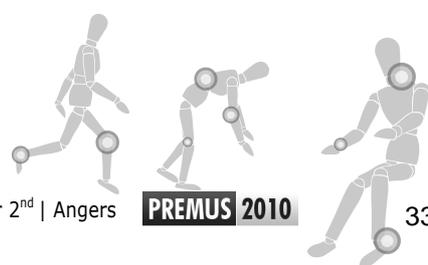
### Results:

The strokes used in hand drumming (West African djembes, Cuban conga and bata drums) involve hitting the drum head with either the palm, the base of the fingers or the fingertips to produce 3 different tones. Extreme energy and speed are required, and the repeated and violent impacts may lead to cumulative trauma disorders. Maintenance and transport of the drums also cause injuries. Other drums and idiophones (tuned percussions, wood blocks, rattles, scrapers and hand held bells) are used by the same players and impose rapid alternating movements or awkward positions of the wrists and hands. The self reported cumulative prevalence of musculoskeletal disorders was very high: 100% of musicians reported at least one medical musculoskeletal problem, the most frequent being carpal tunnel syndrome and shoulder pain (20%), tendinitis of the elbow (16%), followed by back pain and wrist tendinitis (7%). Calluses, swellings and blisters, cuts, skin cracks and infections were also common complaints. We noted that paronychia and finger clubbing were frequent and this requires further analysis. The lack of warm up routines, specialist medical advice and protective equipment (such as harnesses) was alarming.

### Conclusion:

Recent research has shown that the prevalence of playing related musculoskeletal disorders in orchestral percussionists is high. We believe that musicians who play hand drums are even more at risk because of the intensity of their instrumental technique and that epidemiological studies, and even more importantly early prevention, are needed.

**Keywords:** Specific sectors, Early prevention, Upper limb.



## MUSCULOSKELETAL SYMPTOMS AND THE EFFECT OF WORKING IN A COLD ENVIRONMENT AMONG MALE CONSTRUCTION WORKERS

WAHLSTRÖM J., BURSTRÖM L., JÄRVHOLM B., NILSSON T.

*Occupational and Environmental Medicine, Umeå University Hospital & Umeå University, Umeå, Sweden*

### Aims:

The overall aim was to study if work in a cold environment increased the prevalence of musculoskeletal symptoms in the neck and low back among male construction workers.

### Methods:

The study base is a cohort of workers in the Swedish construction industry that participated in health examinations on a regular basis. This analysis is based on workers examined 1971 to 1975 and answering a questionnaire including questions about back and neck pain that had interfered with work during the last year. The cohort consisted of 134 757 male workers including 3350 white-collar workers.

The health examinations of the workers were conducted in 12 different geographic regions. The most northern region was Luleå and the most southern region was Malmö. The average year temperature was about 0°C in the north region compared to 8°C in the south region and the average temperature during the winter months (December to February) was about -11° C in the north region compared to 0° C in the south region during the actual time period. The odds ratios (OR) were adjusted for age, BMI and occupation.

### Results:

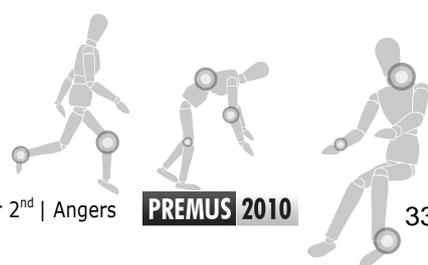
The overall prevalence of low back pain and neck pain the last year that had interfered with work was 23% and 8%, respectively. The prevalence of back and neck pain among the white-collar workers was 14% and 6%, respectively. The occupations among the blue-collar workers with the highest prevalence's of back pain (27-32%) were rock workers, concrete workers, brick layers, preparatory workers and roofers. The occupations among blue-collar workers with the highest prevalence's of neck pain (9-12%) were rock workers, concrete workers, brick layers and painters.

The adjusted OR for low back pain among construction workers in the north region compared to construction workers in the south region was 1.50 (95% CI 1.41-1.59). The adjusted OR for neck pain among construction workers in the north region compared to construction workers in the south region was 1.84 (95%CI 1.68-2.01).

### Conclusion:

The result indicates that working in colder conditions increase the occurrence of neck and low back musculoskeletal symptoms among construction workers.

**Keywords:** Construction, Epidemiology, Back, low back



## FOLLOW UP OF THE EVOLUTION OF SEASONAL WORKERS' PAIN AND MUSCULOSKELETAL SYMPTOMS: RELEVANCE OF MIXED METHODS APPROACH

MAJOR M.E., VÉZINA N.

MAJOR M.E., Département des Sciences Biologiques, CINBIOSE, Université du Québec à Montréal, Canada; VÉZINA N., Département de Kinanthropologie, CINBIOSE, Université du Québec à Montréal, Canada.

### Aims:

The few existing studies carried out in crab plants have shown that musculoskeletal disorders (MSD) are an important problem that may be magnified by the constraints associated with seasonal and precarious work in rural regions. Many workers stay at work despite pain to be eligible for unemployment benefits. The goal of this study is to analyse the evolution of some indicators of the musculoskeletal health of a group of crab plant workers during the season and off-season.

### Methods:

This study was conducted using a mixed methods approach (Tashakkori & Teddlie, 2003) to evaluate potential interest in Ergonomics studies. Data were collected in 2 crab plants during 2 seasons and off-seasons. A multiple case study of 16 workers (8 in Newfoundland, 8 in Quebec) was carried out. Interviews, observations of work activity and organization, analyses of documents and the follow up of some musculoskeletal health indicators (pain symptoms, functional limitations) were conducted. Pain intensity was recorded using body maps where subjects indicated the level of discomfort for each body part at the start and end of their shifts. During the off-season, the maps and interviews were conducted by phone once every 2 weeks. Furthermore, a questionnaire on the workers' functional limitations was administered (Stock & al., 2003).

### Results:

An increase of symptom intensity between the start and end of the work shift was observed for most of the workers. There was a decline in pain intensity after the night but workers started their next shift with pain still remaining. Pain intensity reached the highest levels during the first weeks of the season. Some workers did not recover completely even during the off-season and still have functional limitations. A variation in the number of body sites with pain was also present. However, pain was reported at some sites for the whole duration of the season, particularly for the shoulders. Results could be explained in part by difficulties associated with seasonal work, such as intensification of work, irregular working hours, many consecutive work days without a day off and the work unpredictable nature. Political decisions related to the fisheries industry were also identified to have an impact.

### Conclusion:

Workers keep on working despite pain symptoms and functional limitations which are aggravated at particular times during the crab season. The use of a mixed methods approach contributed to gain deeper understanding of the situation and to identify factors to consider in Ergonomics interventions.

**Keywords:** Intervention studies, Intervention methods, Pain, Chronic pain

### References:

- Tashakkori A. and Teddlie C. (2003). Handbook of mixed methods in social and behavioral research. Sage Publications. California, USA. 768 pages.
- Stock S, Loisel P, Durand M-J., Streiner D, Tugwell P, Reardon R, Lemaire J, Boucher M, Darzins S, Dilworth P, Gaudreault N. (2003). IDVQ : L'indice d'impact de la douleur au cou et aux membres supérieurs sur la vie quotidienne. IRSST, Montréal, Études et Recherches, R-355, 64 pages.



## CHRONIC PAIN AND EMPLOYEE EXPERIENCE AS A STARTING POINT FOR ERGONOMIC EVALUATIONS

CAMPBELL-KYUREGHYAN N., AHMED M.

*University of Wisconsin-Milwaukee, Center for Ergonomics, Milwaukee, USA*

### Aims:

The nature of many jobs requires employees to deal with dynamic and unpredictable conditions that increase the chance of injury. The likelihood of chronic pain is increased with a high level of physical activity, low turnover rate, and aging workforce (Loeser 1999), common in many industries. This study aimed to develop a specific methodology to identify employees with chronic pain using a self-reported questionnaire.

### Methods:

A questionnaire was administered to 30 workers at a power utility company. The questionnaire consisted of employees' job details and a description of pain experienced in the knees, neck, low back, upper back, wrist/hands, and shoulders. Participants with chronic pain were identified using the following criteria: initial pain more than one year previous, pain experienced within the last 12 months, and frequency of pain (at least one or more times per month).

### Results:

Based on the questionnaire responses, there were participants experiencing chronic pain for each body region. Of those experiencing pain, between 40% and 91% had chronic pain, depending on the body region. The relationship between the onset of pain and years of experience, along with the age at the onset of pain, is shown in Figure 1. On average, employees experienced pain from 12 (low back) to 28 (upper back) years after beginning employment (19.33 +/- 5.31 overall). However, the range is large, with some employees experiencing pain within one year of employment.

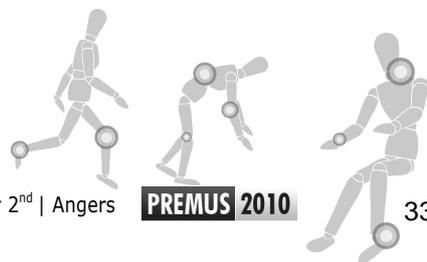
### Conclusion:

Health care and missed work costs are disproportionately impacted by chronic conditions (Stewart 2003). The methodology developed in this project was able to determine the presence of chronic pain in employees using self-reported data. The measured impact of ergonomic interventions is often confounded by chronic problems that cannot be retroactively changed. Determining the presence of chronic conditions will allow for accurate estimation of improvements.

**Keywords:** Specific sectors, older workers, pain, chronic pain

### References:

Loeser J, Melzack R. Pain: An overview. *Lancet*. 1999;353:1607-9.,  
Stewart W, et al. Lost productive time and cost due to common pain conditions in US workforce. *JAMA*. 2003;290:2443-54.



## LIFE STYLE, WORK ENVIRONMENT FACTORS AND MUSCULOSKELETAL DISORDERS IN CARPET HANDLING OCCUPATION

CHAARI N., AKROUT M., BEN KHADIJA J., AMRI C., KHALFALLAH T.

*Laboratoire d'ergonomie, Faculté de Médecine de Monastir, Tunisie*

### Aims:

Musculoskeletal disorders (MSDs) are the major cause of occupational diseases in Tunisia and concern several industries. This study was conducted to determine the prevalence of MSDs symptoms and to identify their risk factors in hand-woven carpet industry.

### Methods:

The study consisted of two phases. In the first, MSDs symptoms were collected using a questionnaire, among 52 women weavers in traditional workshops in Kairouan city (region of Tunisia). This questionnaire compound 148 questions exploring the personal characteristics, working conditions, the psycho-social factors (perception and appreciation of the works situation, work satisfaction, stress symptoms, Karasek questionnaire), health status and Musculoskeletal complaints during the last 12 months. All workshops were visited and the questionnaire was completed by interviewing the weavers. In the second phase, working postures were ergonomically assessed by video recording during a representative working period. It is focused on the body zone interest. The posture of the body segments in the zone of interest (neck, shoulders, elbows, and wrist) is compared to a set of reference postures defined in the literature.

### Results:

The prevalence of MSDs during the 12 months was 69.2% at the neck, 71.1% at the shoulders, 51.9% at the elbows, 69.2% at the wrists, 88.5% at the lower back and 61.5% at the knees. The main risk factors were associated with the static work and awkward posture. Both psychosocial and individual factors did not contribute in the occurrence of these disorders. The ergonomic analysis confirmed the impact of postural constraints. Indeed, the neck was in flexion / extension in 48% of the time, the shoulder in extension in 53%, the wrist in flexion over 30 ° in 49% and the digital making in 76% of time.

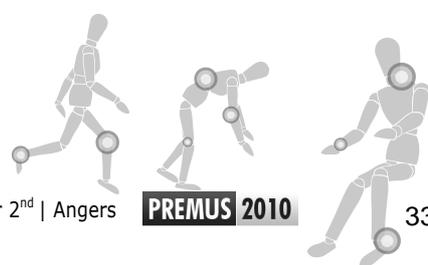
### Conclusion:

The study reported a high prevalence of MSDs in carpet weaving occupation. The main risk factors for developing musculoskeletal symptoms were attributable to poor-designed weaving workstation. Interventional ergonomic program in this occupation should improve the traditionally hand tools designed.

**Keywords:** Biomechanics, exposure measurement methods, social aspects of MSD

### References:

Choobineh A et al. Musculoskeletal problems in iranian hand-woven carpet industry: guidelines for workstation design. *Applied Ergonomics* 2007;38:617-24,  
Motamezade M et al. Ergonomic design of carpet weaving hand tools *International Journal of Industrial Ergonomics* 2007;37:581-87,  
Abdallah B, Khalfallah T, Akrou M, Malchaire J. Prévalence et facteurs de risque des TMS en industrie de confection. *Médecine de Travail et Ergonomie* 2005; 3: 92-7



## PLAYING-RELATED MUSCULOSKELETAL DISORDERS AND STRESS-RELATED HEALTH AMONG PERCUSSIONISTS

FJELLMAN-WIKLUND A., SANDELL C., FRYKMAN M., CHESKY K.

*Department of Community Medicine and Rehabilitation Physiotherapy, Umeå University, Umeå, Sweden*

### Aims:

The aim of this cross-sectional study was to examine playing-related musculoskeletal disorders and stress-related health among percussionists.

### Methods:

Data was extracted from the University of North Texas Musician Health Survey, a large scale survey conducted over the Internet for identifying medical problems experienced by musicians. Participation was requested from all musicians regardless of age, professional involvement, or type of music played. The survey generated a heterogeneous convenience sample of 4017 musicians (1). Subjects for this study (n=279) (female 15%, male 85%) were included if they identified auxiliary percussion, drum set, marimba, steel drum, timpani, vibraphone, xylophone or other percussion as primary instrument. These instruments were combined into three categories, mainly according to types of striking surface. The categories were a) membranophone percussion (drum set, timpani), b) keyboard percussion (marimba, vibraphone, xylophone, steel drum) and c) auxiliary (tambourine, triangle, bells, rattle) and other percussion, as the striking surfaces of auxiliary percussion are heterogeneous and the other percussion group is indefinable.

### Results:

Out of the sample, membranophone percussion was the largest instrument category (60%) followed by auxiliary and other percussion (24%) and keyboard percussion (16%). The prevalence rate for one or more playing-related musculoskeletal disorder (PRMDs) was 77% for the total percussion group. The keyboard percussionists reported the significantly highest prevalence (89%) for one or more PRMDs ( $p=0.038$ ), followed by auxiliary and other percussionists (79%) and membranophone percussionists (74%). The highest prevalence of PRMDs was found in the hands and the low back. Stress due to work environment was considered moderate to high by 75% of the respondents which is comparable to other studies based on the UNT-MHS survey (2, 3). Percussionists reported primarily problems with fatigue (49%), depression (35%), and stage fright (31%).

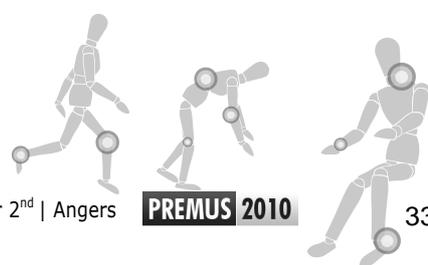
### Conclusion:

PRMDs and stress problems are a major concern for percussionists, and especially keyboard percussionists seem to be most at risk. The surfaces of the keyboard percussion instruments include some of the hardest and most stressful striking surfaces of all percussion instruments. Research indicates that hard striking surfaces often lead to overuse injuries, and that the hands and fingers are most commonly affected. Future research should include longitudinal studies to explore physical as well as psychosocial factors surrounding percussionists' PRMDs. Medical professionals need to acknowledge that percussionists suffer from PRMDs and that they could benefit from health promotion, preventative education and medical treatment.

**Keywords:** Vulnerable workers, Upper limb, Pain, Chronic pain

### References:

- Chesky KS, Corns J, Devroop K. Population characteristics of an internet-based musician survey. In Laufer D, Chesky K, Ellis P (eds.): *Kölner studien zur musik in erziehung und therapie*. Köln, Verlag Christoph Dohr, 2000.
- Pak C, Chesky KS. Prevalence of hand, finger and wrist musculoskeletal problems in keyboard instrumentalists: The University of North Texas Musician Health Survey. *Med Probl Perform Art* 2001; 16:17-23.
- Fjellman-Wiklund A, Chesky KS. Musculoskeletal and general health problems of acoustic guitar, electric guitar, electric bass and banjo players. *Med Probl Perform Art* 2006; 21:169-176.



## PREVALENCE OF MUSCULOSKELETAL SYMPTOMS AMONG CALL CENTER OPERATORS IN SÃO PAULO, BRAZIL

GLINA D.M.R., ROCHA L.E., GALASSO L.

*Faculdade de Medicina da Universidade de São Paulo, LIM-40, São Paulo, Brazil.*

### Aims:

Compare prevalences of musculoskeletal symptoms among call center operators from two call centers in São Paulo, Brazil (air tickets reservation center and managed care service center).

### Methods:

Cross sectional study with 476 operators who voluntarily answered a questionnaire involving: individual characteristics and the presence of musculoskeletal symptoms (tenderness, pain, discomfort) during the past 12 months. Data analysis described the prevalence of symptoms according to: location, intensity and time on sick leave. Ergonomic work analysis included systematic observations and visual documentation of the work, interviews, and hearing of calls.

### Results:

Managed care service center received 120.000 calls monthly and employed 115 operators. Air tickets reservation center received 18.000 calls daily and employed 370 operators.

Employees' characteristics: 75% females; predominant age from 18 to 24 years (46,8%); 45,4% college students; mean salary 200 euro; 70,8% single; 36,6% reported moderate to intense housekeeping activities.

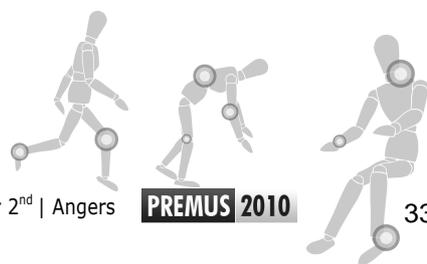
Comparing both call centers: factors related to working conditions showing significant differences were: noise, illumination, temperature, working space/layout, desk, chair, instruments, number of employees and exercises. The managed care service center presented the worst environmental, furniture and instruments conditions and the air tickets reservation center the worst situation concerning demand/number of employees. Concerning job satisfaction statistical significant differences were found in: working schedule, jokes, self fulfillment, quality of the enterprise and quality of the system. Factors of pain and fatigue which showed significant differences were: pressure of "on hold" clients, small number of rest breaks, uncomfortable posture, volume of information, multiplicity of clients' demands, inadequate instruments, lack of work recognition, climate, system mal functioning.

The prevalence of symptoms according to location was: 53,4% on shoulders (IC 95%, 48-58); 52,0% on hands and wrists (IC 95%, 47-56); 48,6% on lumbar column (IC 95%, 44-53); 46,8% on elbows and forearms (IC95%, 42-51) e 42,9% on neck (IC 95%, 38-47). There were 125 (26,2%) workers on sick leave for WD: 52 (10,6%) from 1 to 7 days, 28 (5,9%) from 8 to 14 days e 45 (9,5%) from 15 to 270 days. 85% referred intensity of symptoms between moderate and very strong.

### Conclusion:

Results indicate a high prevalence of musculoskeletal symptoms. Significant differences were observed between the two call centers, with predominance of hand/wrists and elbow/shoulders symptoms in the air tickets reservation center, probably associated with the higher volume of daily calls.

**Keywords:** Computer work, Surveillance, Epidemiology



## PREVALENCE OF MUSCULAR-SKELETAL DISORDERS AMONG MANUAL MATERIAL HANDLING WORKERS IN DAIRY PRODUCT INDUSTRY

HABIBI E.

*Occupational Safety and Ergonomics, Esfahan Medical University, Esfahan, Iran*

### **Aims:**

Muscular-skeletal disorders (MSD) are associated with awkward work posture. The aim of this study is to report the prevalence of MSD; working posture analyzed and investigated lifting-related MSD distributing dairy products workers in Isfahan

### **Methods:**

The working posture of worker (n=50) were observed using the Nordic test and the Ovako Working Posture Analysis System (OWAS). During observation, both working postures and work activities were recorded. Using SPSS was to analyze validity and feasibility of OWAS method.

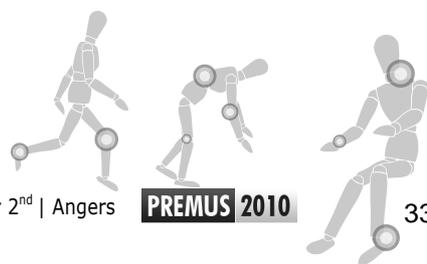
### **Results:**

The prevalence of working posture that is harmful to the musculoskeletal system was high. The prevalence of low back pain (LBP), shoulder disorder, knee disorder and wrist disorder were respectively 86%, 44%, 66% and 28% for more than 24 hours in the past 12 months. 22.82% of working posture was classified in action category 3, 4 which needed to improve. High significant correlation was between OWAS action category and prevalence of MSD (p-value < 0.001, r = 0.57).

### **Conclusion:**

There were high MSD and awkward working posture in this work. Ergonomic interventions and more attention to workers are needed. The method of OWAS is valid tool in assessing characteristics and risk factor of MSD for manual material handling in this work. But it can not assess awkward grasping factor that is important role to incidence of wrist disorder.

**Keywords:** Postures, Physical exposure, Exposure measurement methods, Personal risk factors for MSD



## DETERMINING THE DEGREE OF DISABILITY IN WORKERS WITH UPPER LIMB MUSCULOSKELETAL DISORDERS USING DASH

KIM K.S.

Center for Occupational Disease Research, KOSHA, Incheon, Korea

### Aims:

This study aimed to examine the development and characteristics of the workers with upper limb musculoskeletal symptoms and disorders and to analyze the upper limb musculoskeletal symptoms and disorders for its relationship with the individual socio-demographic characteristics. This study investigated the effect on the limitations of physical activities using standardized surveillance tool and clinical diagnosis.

### Methods:

Musculoskeletal symptoms and the limitations of physical activities were examined. The clinical diagnosis of musculoskeletal disorders were carried out by physical examination, radiological examination and electromyography-electroneuronography for 22 workers in kitchen hood assembly process and 50 workers in toggle process of leather product manufacturing.

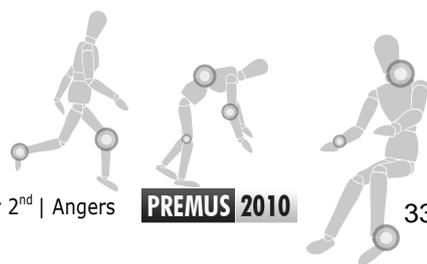
### Results:

The proportion of workers with musculoskeletal disorders was higher and the DASH score was also statistically higher in female and aged workers with longer working hours, longer household working hours, less leisure/hobby activity and higher physical load. Physical activities component score increased in the following order: workers in normal health, workers with musculoskeletal symptoms, and workers with musculoskeletal disorders as clinically diagnosed. Score for each DASH component increased in the following order: sports/performing arts ability, social activities, specific physical functional activities, work or other regular daily activities, work ability, psychological activities, insomnia and upper limb symptoms. The overall and each component DASH scores were higher in workers with symptoms of status praesens and of more severity, and receiving medical intervention.

### Conclusion:

Musculoskeletal symptoms and disorders are associated with individual socio-demographic characteristics, and DASH score for physical activities of upper limb was higher in workers with musculoskeletal disorders. Musculoskeletal symptoms and disorders have a remarkable epidemiological significance for physical activities, social activities, work or other regular daily activities, upper limb symptoms and insomnia, where work ability, sports/performing arts ability and preventive measure is needed.

**Keywords:** Personal risk factors for MSD, upper limb, specific health outcomes



## WORK-RELATED MUSCULOSKELETAL DISORDERS AMONG TAIWANESE FLIGHT ATTENDANTS

LEE K.H., STEWART M.H.

*Cabin Crew Division, China Airlines, Taiwan; Business TAFE School, RMIT University, Melbourne 3000, Australia*

### Aims:

Flight attendants are more likely to experience work-related musculoskeletal disorders (WMSDs) than other commercial air transport workers (IATA, 2006). This study evaluated the presence, location, and severity of WMSDs among flight attendants in a major Taiwanese airline.

### Methods:

The sample comprised 256 female and male flight attendants and pursers. The standardized Nordic Musculoskeletal Questionnaires (NMQ) was used. Of 256 questionnaires distributed,

### Results:

The majority (81.1%) of participants were female. Almost half were women aged 25 to 34 years and 83% had worked as a flight attendant for over 5 years. A high proportion (76.02%) reported WMSD symptoms in at least one body region. The prevalence of WMSDs for Taiwanese flight attendants (8.4 – 55.4%) was lower than for long haul American flight attendants (50 – 86%) but similar to Scandinavian Airlines, where symptom presence ranged from 21% to 58% (Lee, Wilbur, Conrad, Mokadam, 2006). The majority of Taiwanese flight attendants were aged 25 to 44, which is younger than the average age of 54 for American flight attendants. Age, therefore, may be a significant factor, though how this affects WMSD rates may be complex.

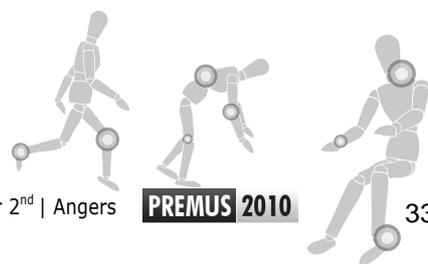
### Conclusion:

In the USA, the prevalence rates in one study were, highest to lowest: lower back, wrist, neck, and shoulders. In this study, prevalence rates were highest in the upper extremity: wrist, shoulders, lower back and knees. Reasons for both incidence rate and differences could relate to age, differences in task routines and cultural practices such as greater assistance with Taiwanese passenger carry-on baggage. This study supports previous studies which recommend further research and comparative risk assessment of flight attendants' job tasks.

**Keywords:** Specific sectors, personal risk factors for MSD, back, low back

### References:

- Lee, H., Wilbur, J., Conrad, K.M., Mokadam, D. Work-related musculoskeletal symptoms reported by female flight attendants on long-haul flights. *Aviation, Space, and Environmental Medicine*. 2006; 77(12): 1283-1287.
- Kao, L.-H. Lee, Stewart, M.H., Lee, K.-H. Using structural equation modeling to predict cabin safety outcomes among Taiwanese airlines. *Transportation Research Part E*. 2009; 45: 357-365.
- Kee, D., Seo, S.R. Musculoskeletal disorders among nursing personnel in Korea. *International Journal of Industrial Ergonomics*. 2007; 37: 207-212.



## RISK OF CERVICAL AND LUMBAR INTERVERTEBRAL DISC HERNIATION (HIVD) AMONG MALE BUS DRIVERS

LIOU S.H., WANG G.H., TSAI S., LEE H.J., SHIH T.S.

National Health Research Institutes, Taiwan

### Aims:

More and more HIVD cases, either cervical or lumbar spine, among bus drivers were applied for occupational disease compensation. Cervical and lumbar HIVD were in the lists of occupational diseases in Taiwan. We have already set up the diagnostic criteria for cervical and lumbar HIVD as occupational diseases. One possibility is that whole-body vibration caused by the vehicle leads to accelerated disc degeneration, herniation, and associated symptoms. The aim of this study was to estimate the risk and elaborate the risk factors of herniation of cervical and lumbar intervertebral disc among male bus drivers in Taiwan.

### Methods:

We analyzed the cross-sectional data from the Bus Drivers' Health Study. Standardized questionnaires were used to collect information on personal characteristics, work-related physical and psychosocial factors, work shifts, sleeping quality, and driving time profiles. Musculoskeletal disorders prevalence was assessed by the modified Nordic Musculoskeletal Questionnaire. Cases of cervical or lumbar spinal HIVD were confirmed by physicians. Multiple logistic regression models were employed for statistical analyses.

### Results:

The prevalence of cervical and lumbar intervertebral disc herniation were 22/1240 (1.8%) and 72/1240 (5.8%), respectively. Disc herniation did not differ between occupational drivers and controls. We also did not identify any risk factor for greater risk of cervical and/or lumbar HIVD in bus drivers, after adjusted for potential confounders. No dose-response relationship was found for driving hours, driving years and vibration intensity on cervical or lumbar spinal HIVD.

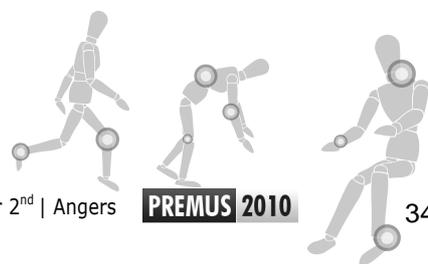
### Conclusion:

Although long-haul driving may exacerbate symptoms of back problems due to long sitting, it does not damage the disc. However, this should be further investigated in prospective studies. Future studies are needed to examine the potential adverse effects of prolonged exposure to low levels of whole-body vibration. Our inability to identify increased risk in bus drivers should provide evidence to against occupational HIVD in bus drivers, in contrast to truck drivers with potential exposure to high vibration intensity in trucks used for agriculture, construction, and heavy duty.

**Keywords:** Epidemiology, back, low back, neck

### References:

- Jensen MV, Tüchsen F, Orhede E. Prolapsed cervical intervertebral disc in male professional drivers in Denmark, 1981-1990. A longitudinal study of hospitalizations. *Spine (Phila Pa 1976)*. 1996 Oct 15;21(20):2352-5.
- Chen JC, Chang WR, Chang W, Christiani D. Occupational factors associated with low back pain in urban taxi drivers. *Occup Med (Lond)*. 2005 Oct;55(7):535-40.
- Kelsey JL, Githens PB, O'Conner T, Weil U, Calogero JA, Holford TR, White AA 3rd, Walter SD, Ostfeld AM, Southwick WO. Acute prolapsed lumbar intervertebral disc. An epidemiologic study with special reference to driving automobiles and cigarette smoking. *Spine (Phila Pa 1976)*. 1984 Sep;9(6):608-13.



## DETERMINATION OF WORKING CONDITIONS, MUSCULOSKELETAL COMPLAINTS AND MUSCULAR ACTIVITY DURING OFFICE WORK

LUTTMANN A., SCHMIDT K.H., JÄGER M.

*IfADo - Leibniz Research Centre for Working Environment and Human Factors, Dortmund University of Technology, Germany*

### Aims:

Office workers often report musculoskeletal complaints in spite of relatively small forces released during occupational activity. Possible reasons are long-term muscular activities needed for posture stabilisation or repetitive movements of high accuracy applied to operate the computer. The aim of the study was to investigate working conditions as well as muscular activities and complaints during real office work.

### Methods:

69 employees of a tax office answered a questionnaire regarding their activity, the working tools and the spatial arrangement of the equipment as well as musculoskeletal symptoms ('Nordic Questionnaire', Kuorinka 1987). In a subgroup of 13 employees 4 surface electromyograms (EMG) were recorded in the right neck-shoulder-arm region during total working shifts. Simultaneously the actual activity was documented using an encoding procedure. At four points in time during the day the subjects indicated actual musculoskeletal complaints.

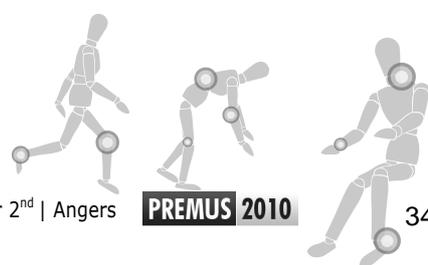
### Results:

The most frequent activity of the persons is related to computer work, followed by paper work and communication activities such as phoning, speaking, or participating in meetings. About 50% of the subjects indicated complaints for at least 8 days during the last 12 months for the neck and the lower back, and about 40% and 30% for the right or the left shoulder, respectively. The average EMG amplitude was highest for the shoulder muscles during paper work and for the forearm during keyboard application. Temporal changes of the EMG amplitude and frequency spectrum were studied and a previously developed method for 'Joint Analysis of the EMG Spectrum and Amplitude (JASA)' (Luttmann et al. 2000) was used to identify the cause for the EMG changes as 'fatigue', 'recovery', 'force increase' or 'force decrease'. For several persons muscular fatigue was found for the hand extensor muscle during keyboard operation and for the right trapezius muscle during paper work. For the majority of persons a decrease in the force production during the day was found. Comparison of the EMG changes with complaints reveal that persons with a steeper decrease in the EMG amplitude of the shoulder muscles mentioned a lower number of shoulder complaints than persons with less EMG change.

### Conclusion:

It is concluded that persons with a low number of complaints perform a self-adjustment of physical activity aiming for the avoidance of pain. Therefore, lowering of muscular activation in the course of the working day is assumed to be helpful to prevent muscular complaints.

**Keywords:** Muscle activity ,computer work ,upper limb



## WORK RELATED FACTORS OF BACK PAIN AMONG GARMENT FACTORY WORKERS IN INDONESIA

MANSYUR M., LUTAM B., JANNIS J.

Occupational Medicine Division, University of Indonesia

### Aims:

Personal risk factors for musculoskeletal disorder (MSD) are important component of the prevention programme planning at the workplace. Back pain is prominent among the work related musculoskeletal disorders. This study is aimed at exploring the work and personal related factors of back pain.

### Methods:

This study used a case – control study which was performed at a garment factory in Indonesia. Both case and control subjects were randomly chosen from 1361 female workers in sewing department. Seventy five woman cases were chosen and re-examined from woman workers who were diagnosed back pain based on the medical record data of the factory clinic. The same numbers of controls were randomly chosen from the same task of woman workers. The collections of data were done by using questionnaire to obtain back pain related variables, anthropometric measurements to obtain the ergonomic variables, and anamnesis and physical examinations to determine the diagnosis of back pain.

### Results:

The analysis found that the back pain related determinant factors are five years length of service or more (adj. OR=7.32; 95%CI=3.19-16.52), the height of elbow in sitting position of 69 cm or more, and the marital status. The female workers who have the length of service more than 5 years tend to have more than 7 times risk than For those who have the height of elbow in sitting position more than 69 cm (adj. OR=3.60; 95%CI=1.54-8.40). In addition, married female workers have 4.12 times more risk to get back pain than those who were unmarried (adj. OR=4.12; 95%CI=1.50-11.27).

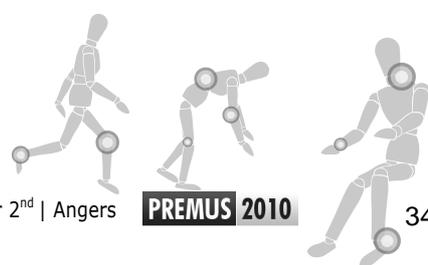
### Conclusion:

The mechanism of back pain is probably linked to prolonged work and sit close enough to the work objects by leaning forward during doing their work. It is proved that female workers who have the height of elbow in sitting position more than 69 cm got 3.6 more back pain risk than those who have it 69 cm or less. Therefore, it is recommended to adjust the work position to the workers anthropometric, to do rotation of work for those who have done work of 5 years or more, and to give workers time to do rest and stretching for about minutes every 2 work hours.

**Keywords:** Postures, Physical exposure, Personal risk factors for MSD, Back, Low back

### Reference:

Kaegard A, Andersen JU. Musculoskeletal disorders of the neck and shoulders in female3 sewing machine operators: prevalence, incidence, and prognosisOccupational Environmental Medicine. August 2000; 57:528-554



## MUSCULOSKELETAL SYMPTOMS AND RISK FACTORS FOR MUSCULOSKELETAL DISORDERS AMONG CALL CENTER OPERATORS IN BRAZIL

JANUÁRIO L. B., MIRANDA L.C.J., OLIVEIRA A.B.

Department of Physical Therapy, Federal University of São Carlos, São Carlos, Brazil

### Aims:

Computing the prevalence of musculoskeletal symptoms among call center operators and point out possible causes.

### Methods:

The Nordic Musculoskeletal Questionnaire (NMQ) was applied among 241 workers (68% of women) of one call center of a large size energy company in Brazil. The mean age of the workers was 26.01 (SD:7.94 years) and they had different level of experience and time of work in this current job. The NMQ was applied according to the workers' shift. Besides the questionnaire, an ergonomic workplace analysis (EWA) was performed according to the Brazilian Legislation on Ergonomics.

### Results:

Figure shows the results of the NMQ for symptoms during the last 12 months and 7 days. For the last 12 months the complaints were concentrated on upper and lower back, neck and shoulders. Considering the last 7 days, there was less symptoms which were concentrated at lower back (27%), neck (26%), upper back (24%) and shoulders (22%). The EWA showed that the company follows the recommendations and workplaces are adequate.

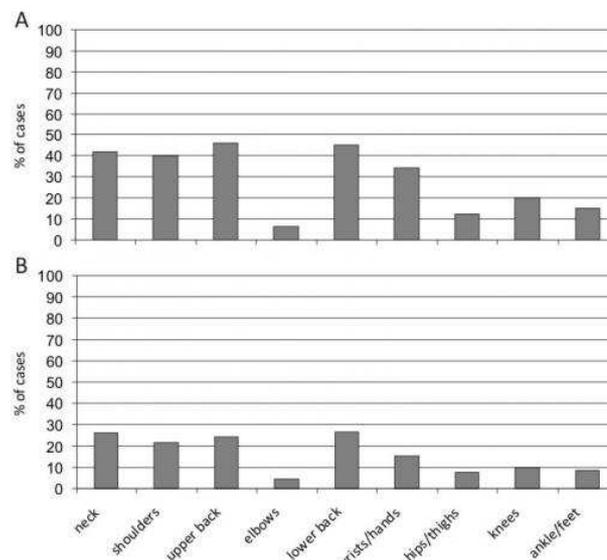


Figure: Results of the Nordic Musculoskeletal Questionnaire: annual prevalence of symptoms on specified body regions (A); weekly prevalence of symptoms on specified body regions (B).

### Conclusion:

The body regions presenting symptoms are probably related to the nature of this work. Seated posture causes an increase of 35% on the intradiscal pressure, which may explain symptoms at the lower back. Muscular static work can be related to the symptoms of upper back, neck and shoulders. This kind of load can be explained by 3 risk factors: low muscular rest, low variation in activity and high mental stress (THORN, 2005). When comparing the results of NMQ with a previous study involving computer workers (OLIVEIRA et al, 2008) the prevalence of symptoms recorded here occurs at the same body regions but it is considerably lower (-30%). Possible causes for this difference are better work conditions identified by the EWA as well as fewer working hours and mean age of the operators.

**Keywords:** Computer work, Specific sectors, Epidemiology

### References:

- THORN S. Muscular activity in light manual work – with reference to the development of muscle pain among computer users. Doctoral Thesis. Chalmers University of Technology, Göteborg, Sweden, 2005.  
 OLIVEIRA AB, VINGÅRD E, GIL COURY HJC. Musculoskeletal symptoms and physical and psychosocial risk factors among administrative workers from public work sector. Proceedings of the XV Brazilian Congress on Ergonomics, ABERGO, Porto Seguro, Bahia, 2008.



## PREVALENCE OF MUSCULOSKELETAL DISORDERS AND PHYSICAL RISK FACTORS AMONG METAL WORKERS

ÖZCAN E.<sup>1</sup>, ALPTEKIN K.<sup>1</sup>, UYSAL B.<sup>1</sup>, ISSEVER H.<sup>2</sup>

<sup>1</sup> Musculoskeletal Disorders and Ergonomics Unit, Department of Physical Medicine & Rehabilitation, Istanbul Medical Faculty, Istanbul University, Istanbul, Turkey - <sup>2</sup> Public Health Istanbul Medical Faculty, Istanbul University, Turkey.

### Aims:

Musculoskeletal disorders developed by heavily physical loading and inappropriate working conditions due to physical activities at work station is a major health problem of workers. Metal workers are under the risk of musculoskeletal disorders because of great physical effort is required.

The main aim of that study is to determine the prevalence and physical risk factors of MSD among metal workers.

### Methods:

The study has been done in metal industry factories at Istanbul and nearby. 500 questionnaires sent, only 167 of them returned. The questionnaire included personal characteristics and working conditions. Test- Retest reliability study of questionnaire was performed. Pearson, Chi Square ve Fisher's Exact Test were used for statistical analyse.

### Results:

Prevalence of MSD in last 12 months was 81,9%. The prevalence rates of musculoskeletal complaints at the last 12 months were found as follows:

low back with 65,7%, back with 54,3% neck with 48.2%, shoulder with 43,8%, knees with 37,0%, hands with 34,0%, feet with 31,7%, hips with 30,1%.

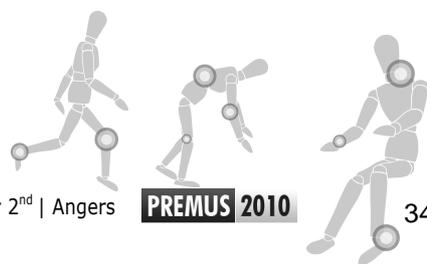
Most significant relations were as at the below when work activities were seperately assessed as risk factors. Back pain was observed among people lifting 20 kg and above frequently at work as 72.5% ( $p=0.000$ ). Low back pain was found out among people lifting 20 kg and above frequently at work as 79.4% ( $p=0.001$ ). Shoulder pain was established among people pulling weight about 5-20 kg as 50.4% ( $p=0.017$ ). Feet pain was observed among people carrying weight about 5-20 kg as 47.4% ( $p=0.03$ ). Elbow pain among people carrying 20 kg and above was stated as 72.2% ( $p = 0.001$ ).

86 of workers (51,8%) applied to doctor because of complaints . 56 of workers (33.7%) received reports and were absent from work because of MSD.

### Conclusion:

Metal workers are under high risk of musculoskeletal disorders, especially of low back pain. We suppose that ergonomic interventions can prevent metal workers from MSD.

**Keywords:** Musculoskeletal Disorders, Metal Workers, Risk Factors, Ergonomics.



**MUSCULOSKELETAL COMPLAINTS AMONG CLASSICAL MUSICIANS IN DENMARK**PAARUP H.M.<sup>1</sup>, HOLM J.C.W.<sup>2</sup>, WEDDERKOPP N.<sup>3</sup>, MANNICHE C.<sup>3</sup>, BÆLUM J.<sup>1</sup><sup>1</sup> Research Unit of Occupational and Environmental Medicine, Institute of Clinical Research, The Faculty of Health Sciences, University of Southern Denmark, Odense, Denmark - <sup>2</sup> Department of Occupational Medicine, Køge Hospital, Denmark - <sup>3</sup> Spine Center South Denmark, The Research Department, Middelfart, Denmark.**Aims:**

To estimate the extent of musculoskeletal problems among professional classical musicians and describe characteristic anatomic patterns and risk factors.

**Methods:**

In Denmark 600 musicians are full-time employed in the seven Danish professional symphony orchestras. The musicians from six of these orchestras, in total 441 musicians, received a questionnaire about health and working conditions and were invited to an examination of the neck, back and upper limbs. The questionnaire was filled in by 78% (n=342) while 49% (n=216) took part in the physical examination.

The questionnaire included former and current playing exposure, musculoskeletal symptoms within the last 12 months in 12 anatomic regions, injuries, use of health care providers and medicine, leisure time activities, and social relations. The musicians were compared to a representative sample of the Danish workforce.

**Results:**

The mean age was 46.8 (range 21-68) years for men; 41.7 (range 23-68) years for women. For all instrument groups the most frequent complaints were in the neck, back, and shoulders. The prevalences of complaints were considerably higher among females than among males and for both genders the prevalences of complaints were significantly higher among musicians than in the background workforce (p<0.0001).

**Table: Number of questionnaire respondents and prevalence of self-reported musculoskeletal complaints within the last week for three selected anatomic regions.**

	Respondents (N)		Neck		Right shoulder		Right hand	
	M	F	M	F	M	F	M	F
High string players (1 <sup>st</sup> and 2 <sup>nd</sup> violin, viola)	63	86	40%	66%	21%	35%	16%	16%
Low string players (cello, double bass)	43	16	53%	63%	30%	44%	19%	44%
Woodwind players (flute, clarinet, oboe, bassoon)	41	21	27%	52%	12%	38%	15%	33%
Brass players (trumpet, horn, trombone, tuba)	46	7	35%	86%	17%	29%	4%	14%
Others (percussion, timpani, harp, piano/organ)	15	4	40%	50%	20%	25%	20%	50%
<b>All instruments</b>	<b>208</b>	<b>134</b>	<b>39%</b>	<b>64%</b>	<b>20%</b>	<b>36%</b>	<b>14%</b>	<b>23%</b>
General workforce <sup>1</sup>	5,855		12%	22%	9%	16%	5%	10%

M: Males. F: Females

**Conclusion:**

Among musicians as well as in the general workforce the most common complaints were related to the neck and back.

Compared to the general workforce the musicians showed a two to three fold increase in prevalence of complaints within the last week for most anatomic regions.

Irrespective of the played instrument female musicians reported more complaints than males - a gender difference that is also seen in many other occupations [1].

The neck and the right hand accounted for the largest prevalence ratios when comparing the musicians to the general workforce; this finding is consistent with the ergonomic strain of most musical instruments.

**Keywords:** Epidemiology, Neck, Pain, chronic pain.

**Reference:**

[1] Burr H, Jensen C. Bevægeapparatbesvær - Arbejdsmiljø i Danmark 2000 [Musculoskeletal symptoms - Working environment in Denmark 2000]. Copenhagen: National Institute of Occupational Health; 2002. 24 p. Danish.



## WRMD: A COMPARISON BETWEEN OFFICE AND PRODUCTION PERSONNEL.

SERRATOS-PEREZ J.N.<sup>1</sup>, HERNANDEZ-ARELLANO J.L.<sup>2</sup>, NEGRETE-GARCIA M.C.<sup>3</sup>, SANCHEZ-OBREGON R.A.<sup>3</sup>

<sup>1</sup> Departamento de Ciencias Aplicadas al Trabajo, Universidad de Guanajuato - <sup>2</sup> Departamento de Diseño Industrial, Universidad Autónoma de Ciudad Juárez. - <sup>3</sup> Departamento de Medicina y Nutrición. Universidad de Guanajuato.

### Aims:

To compare the incidence rates for WRMDs between two groups of personnel at a heavy goods production facility, in Guanajuato, Mexico.

### Methods:

Two samples of personnel were asked to fill-in a questionnaire about the presence of work-related musculoskeletal complaints or pain, as well as the environmental conditions in their work places. One group was 118 individuals who used a computer as their main work tool, in an office environment; a part of them performed administrative tasks, the rest prepared blueprints and calculations for the goods. The other group was 101 individuals who performed the production tasks, having to face heavy physical demands. They worked either with their hands only, or using heavy tools and machinery.

### Results:

Eighty-five (72%) of the office-based workers declared the presence of musculoskeletal trouble/pain in a period of 15 days previous to the date of the enquiry. The most frequently affected body regions were neck (42 counts) and low back (38 counts). Among the workers in charge of production operations, 53% (54 individuals) declared the presence of musculoskeletal trouble/pain. Lower back was the most troubled body region in this group, with 26 counts. Feet came as a far second next, with 14 mentions to each, left and right foot.

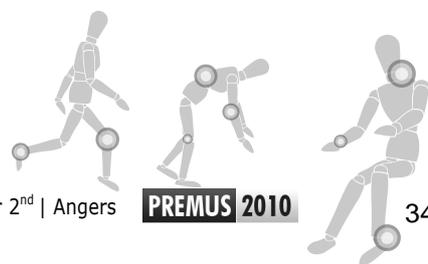
### Conclusion:

It is quite remarkable that more sedentary, office-based personnel were the most affected by musculoskeletal complaints, compared to workers who face a more strenuous workload. Nonetheless, both groups coincided in pointing to the back as the site for their major complaints. It seems very likely that postural bad habits and long working hours are the main causes for trouble among the office-based personnel, whereas among the production personnel it is the need to exert considerable force and/or handle heavy loads.

**Keywords:** Postures, physical exposure, specific sectors, back, low back

### Reference:

California-Arizona Consortium. Programa de Salud Laboral. University of California, Berkeley.



## MUSCULOSKELETAL DISORDERS AMONG WOMEN FARMERS: A COMPARISON OF TRADITIONAL AND IMPROVED TOOLS

SINGH S., RATHORE H., SINWAL N.

College of Home Science, Maharana Pratap University of Agriculture and Technology, Udaipur-313003, India

### Aims:

The present study was undertaken to assess the muscular stress of rural women of Rajasthan, INDIA, while performing different farm and allied activities with the use of traditional as well as improved tools

### Methods:

Thirty rural women who were in average state of health were involved in the experiment. Muscular stress resulting from selected drudgery prone farm activities were measured in terms of four parameters i.e. frequency of postural change, change in grip strength, angle of deviation of backbone and the incidence of musculo skeletal problems.

### Results:

The women changed postures very frequently while performing farming and allied activities. The results showed that the frequency of change in posture reduced with the use of improved technologies.. Significant reduction ( 80%) was observed in squatting posture in briquetting activity, maximum reduction in sitting posture (66.7%), standing & squatting (50%) was found during maize shelling activity.

Hand operated maize sheller led to 33% reduction of postural change during sitting. For animal husbandry activities the use of rake, shovel and wheel barrow brought 100 percent reduction in

The data depicted that there was 1 to 6 degree lesser deviation in normal angle of backbone while using improved technologies as compared to the traditional.

Similarly the percent change in grip increased with the use of improved technologies. It increased by 65% while cleaning of grains with hanging cleaner, 32% by hand operated maize sheller and 20% while using briquetting machine.

The percentage reduction of pain in different body parts experienced by women showed that there was 100% reduction in shoulder pain while using hand operated maize sheller, rake and shovel. In briquetting activity the pain in knees reduced by 60 percent.

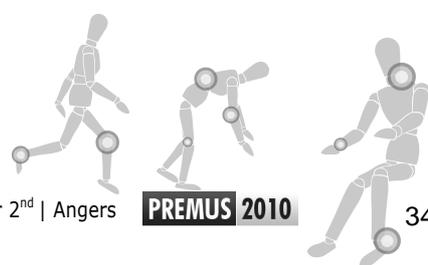
### Conclusion:

It is concluded that with the use of improved tools, the work postures improved which reduced muscular stresses of women while performing the selected activities and enhanced the work efficiency and health of farm women.

**Keywords:** Postures, physical exposure, agriculture intervention studies

### References:

- Corlette EN, Bishop RP. A technique for assessing postural discomfort. *Ergonomics*. 1976; 19: 175-182., Das B, Sengupta AK. Industrial workstation design: A systematic ergonomics approach. *Applied Ergonomics*. 1996; 27:157-63.  
Genaidy AM, al-Shedi AA, Shell RL. Ergonomics risk assessment: Preliminary guidelines for analysis of repetition force and posture. *J Hum Ergol* 1993; 22:45-55



## MUSCULOSKELETAL ALTERATIONS AND COMPLAINTS AMONG GUITAR AND PIANO STUDENTS.

SOTELO-BARROSO F., PODZHAROVA E., VOLKHINA G., MONTENEGRO-VIDAL J., SERRATOS-PÉREZ J.N., RANGEL-SALAZAR R.

*Departamento de Ciencias Aplicadas al Trabajo, Departamento de Música, Universidad de Guanajuato.*

### Aims:

To determine the prevalence of musculoskeletal alterations (MSA) and complaints (MSC) affecting the hands and wrists among guitar and piano students in Guanajuato, Mexico.

### Methods:

Thirty six guitar and piano students (9 female, 27 male) were submitted to a thorough orthopedic and biomechanical examination. They also answered a modified version of the Standardised Nordic Questionnaire for Musculoskeletal Symptoms.

### Results:

Results: 80% out of the total sample declared presence of pain in one or both of their hands and wrists. Right hand was the most frequently affected segment. 44% of the subjects reported the presence of parestias; 30.5% paresthesias and 27.7% edema. 69.4% of the students showed pain during instrument playing. In the orthopedic examination, 75% out of the total sample exhibited at least one musculoskeletal alteration. The most prevalent condition was tendinitis (38%), followed by carpal tunnel syndrome (25%) and extreme muscle fatigue (16%).

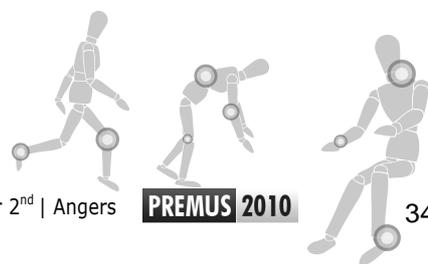
### Conclusion:

Both MSC and MSA are highly prevalent among guitar and piano students. The performance demands, and the repeated instrument play assignments, appear to be the major causal factor for MSC and MSA. Subjects pointed to repetitiveness, long hours of exposure, and awkward postures they must adopt when playing instruments. These activities may result in playing-related musculoskeletal disorders. In this study, in accordance with subjects' reports, the presence of hand and wrist pain was related to the instruments' performance. Future studies should be designed to determine the possible risk-related factors for specific MSC and MSA.

**Keywords:** Postures, Physical exposure, Specific sectors, Epidemiology

### References:

- Burns N & Grove S. Ethics and Research. In: The practice of nursing research. Conduct, critique & utilization. Third edition. Ed: W.B. Saunders Company. Philadelphia, Penn, 1997: 195-223.
- Zaza C. Playing-related musculoskeletal disorders in musicians: a systematic review of incidence and prevalence. CMAJ 1998;158:1019-25.
- Bruno S, Lorusso A, L'Abbate N. Playing-related disabling musculoskeletal disorders in young and adult classical piano students. 1: Int Arch Occup Environ Health. 2008 Jul;81(7):855-60.



## PREVALENCE OF MUSCULOSKELETAL DISORDERS AMONG FEMALE OFFICE WORKERS FROM A MEDICAL UNIVERSITY

VIRAGH E., VIRAGH H.

*Targu-Mures University of Medicine & Pharmacy, Romania*

### Aims:

Numerous reported data from the literature of specialty evidenced that musculoskeletal disorders (MSDs) occur frequently in office workers due to very different causes, such as human-machine/ computer interaction, inadequate work environment, different psychosocial factors (mainly job stress and negative habits).

This study was performed to determine the prevalence and presumptive etiology of MSDs among female office workers from a medical university before and after some ergonomic improvements regarding the MSDs-generating factors (“the responsible factors”).

### Methods:

A group of 64 female office workers were studied (mean age =  $35.7 \pm 6.3$  yrs and mean number of years at work  $11.4 \pm 3.5$ ) before and after the ergonomic improvements. The interaction between the female workers and the job demands was determined (ergonomic assessment). Clinical examinations were done and a computed epidemiological questionnaire was given to collect data about the occupational and non-occupational factors related to MSDs (symptoms and presumptive etiology). Prevalence of different MSDs was calculated before and after the ergonomic improvements. Comparative Score Method was used and Multifactor Analysis was performed for data processing.

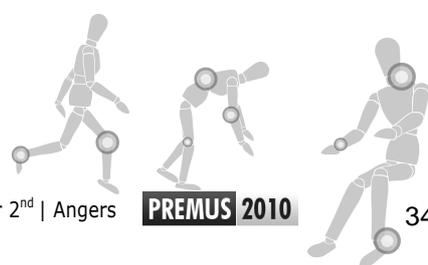
### Results:

Prevalence of the observed MSDs included: low back pain (LBP: 16.7% vs.5.9%), neck pain (NP: 13.6% vs.3.9%), shoulder pain (SP: 15.8% vs.6.1%), upper extremity pain (UEP: 11.3% vs. 3.6%) and lower extremity pain (LEP: 7.9% vs. 2.1%), all significantly higher ( $p < 0.05$ ) before the ergonomic improvements. Ergonomics, as a discipline involves arranging the work environment to fit the person into it. Work stress (score: 26.8), work environment deficiency (score: 13.9), familial problems (score: 15.6), negative habits (score: 4.5) and female health problems (score: 6.3) were strongly involved in MSDs onset. Multifactor Analysis have shown the differing role of work conditions, psychosocial factors and heredity in the occurrence of MSDs in studied female group before and after the ergonomic improvements.

### Conclusion:

The prevalence of MSDs was significantly higher in the studied female office workers before the ergonomic improvements due to the specific work conditions and to the effect of existing negative psychosocial work factors. Following ergonomic principles helps reduce work stress and eliminate many potential injuries and disorders associated factors, as bad posture, and repeated tasks. Improving tasks, work spaces, controls, displays, tools, lighting and equipment help us to fit the employee’s physical, psychosocial capabilities and limitations.

**Keywords:** Surveillance, Pain, Chronic pain, Other



## RISK FACTORS FOR PLANTAR FASCIITIS AMONG ASSEMBLY PLANT WORKERS

WERNER R., GELL N., HARTIGAN A., WIGGERMAN N., KEYSERLING W.M.

University of Michigan, USA

### Aims:

The aim of this study was to determine the relative contributions of work activity (time spent standing, walking or sitting), floor surface characteristics, weight, BMI, age, foot biomechanics, and other demographic and medical history factors to the prevalence of plantar fasciitis

### Methods:

A cross-sectional observational study design was used to study workers at an automobile engine assembly plant. The main outcome measure was the finding of plantar fasciitis on physical examination. The independent variables included baseline demographics, medical history, ergonomic exposures, psychosocial factors, discomfort ratings, shoe characteristics and foot biomechanics. The demographics were collected from an expanded symptom questionnaire. The exposure data was collected from video surveillance, pedometer recordings and structured interviews with workers at the end of their shift.

### Results:

The study demonstrated that forefoot pronation on physical examination, high metatarsal pressure on the gait assessment, increasing time spent standing on hard surfaces, increased time spent walking, medium tenure at the plant, and for the truck/forklift drivers, an increased number of times getting in and out of the vehicle increased the risk of presenting with plantar fasciitis. Rotation of shoes during the work week was found to reduce the risk of presenting with plantar fasciitis. Increased supervisor support showed a trend toward reducing the prevalence of plantar fasciitis.

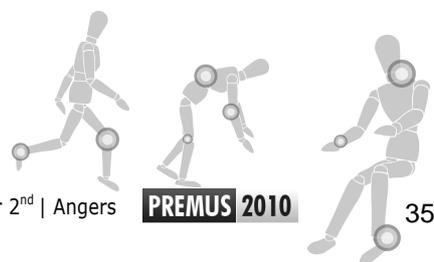
### Conclusion:

Plantar fasciitis is relatively common in the manufacturing setting. These findings suggest several options for primary and secondary prevention strategies. Shoe rotation seems to be an effective strategy which may be used as either a primary or secondary strategy. The use of shoe orthoses with a medial longitudinal arch and metatarsal pad may be used in the same way. Work stations that decrease the percentage of time walking or standing on hard surfaces (e.g., allowing workers to alternate between sitting and standing postures, and/or providing cushioning mats for concrete surfaces) may lower the risk for plantar fasciitis.

**Keywords:** Biomechanics, Epidemiology, Lower limb

### References:

- D'Souza J, Franzblau A, Werner RA. Review of epidemiological studies on occupational factors and lower extremity musculoskeletal and vascular disorders and symptoms. *J Occ Rehabil* 2005, 15:129-165.  
Keyserling, W.M., Wiggermann N., Werner RA, Gell N. Inter-worker Variability in Lower Body Postures During Assembly Line Work: Implications for Exposure Assessment. in press *J Occ Environ Hyg* 2009.  
Riddle DL, Pulisic M, Pidcoe P, Johnson RE. Risk factors for plantar-fasciitis: A matched case-control study. *J Bone Joint Surg* 2003; 85a(5): 872–877.



## EPIDEMIOLOGY OF THE NECK AND UPPER LIMB

### MEASURED AGREEMENT BETWEEN DIFFERENT RESEARCH CASE DEFINITIONS FOR CARPAL TUNNEL SYNDROME

EVANOFF B., DESCATHA A., DALE A.M., COOMES J., FRANZBLAU A.

*Washington University School of Medicine, St. Louis, MISSOURI, USA*

#### **Aims**

Many research definitions of carpal tunnel syndrome (CTS) exist in the literature, yet the overlap of the various case definitions has not been explored. Our study compared agreement between different epidemiological case definitions of CTS using data from a study of a general working population.

#### **Methods:**

We performed a literature search over the past 20 years for studies proposing CTS case definitions for population-based research or surveillance. Different case definitions were mapped to the variables available from a population based study of 1107 newly-employed workers. We calculated the prevalence of CTS using different case definitions, and measured agreement between definitions using the Kappa statistic.

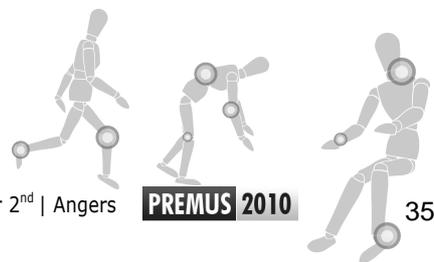
#### **Results:**

We found 7 suggested case definitions of CTS for population-based studies. Case definitions used different combinations of parameters, including symptoms only, symptoms and physical examination, symptoms and either physical examination or median nerve conduction study, or symptoms and nerve conduction study. The prevalence of CTS in our population ranged from 2.5% to 11.0% using different case definitions. Overall, the percentage of disagreement was lower than expected between different case definitions, with Kappa values ranging from 0.30 to 0.85. The largest differences were seen between case definitions requiring symptoms only, and those requiring symptoms and nerve conduction abnormalities.

#### **Conclusion:**

Different case definitions of CTS show reasonable agreement. Though the difference in prevalence was wide using different case definitions, the relatively good agreement observed between many case definitions suggests that results are comparable across studies of risk factors of CTS using different case definitions.

**Keywords:** Epidemiology, Carpal tunnel syndrome, Other.



## DETERMINING THE LEVEL OF EVIDENCE ASSOCIATED WITH RISK FACTORS FOR CARPAL TUNNEL SYNDROME: A SYSTEMATIC REVIEW

BOOCOCK M.G., TREVELYAN F., TAPPIN D., MCNAIR P.J., LARMER P.J., GRIFFITHS R.F., SIMMONDS M., TILSON T., MILLER C.

*Health and Rehabilitation Research Institute, Auckland University of Technology, Auckland, New Zealand*

### Aims:

Understanding and assessing the contribution of the workplace risk factors in the aetiology of Carpal Tunnel Syndrome (CTS) remains a problem for health professionals, as well as worker compensation organisations. The aim of this study was to undertake a systematic review of the literature to determine the evidence linking CTS to individual, psychosocial or physical task-related risk factors.

### Methods:

A search was undertaken of ten electronic databases to identify previous review articles for CTS. Two high quality review articles on risk factors for CTS (Palmer et al., 2007; Bernard, 1997) provided a starting point for the current literature search. All articles included in these previous reviews were sourced and then supplemented with articles published after completion of both reviews by searching the 10 electronic databases. The search used an extensive keyword list that incorporated recognised disease terminology for CTS and descriptors of potential risk factors. All papers were critiqued and scored according to guidelines for assessing the quality of prognostic studies (Hayden et al., 2006). Only those papers achieving the required score for the relevant categories of study methodology were included in the review. A 'pattern of evidence' approach which considered both positive and negative findings in papers was used to grade the level of evidence associated with risk factors.

### Results:

Of the 252 articles meeting the inclusion criteria, 76 articles achieved the required quality score. For those studies that considered physical risk factors, there was strong evidence linking CTS and awkward posture, with 12 of 16 studies reporting positive findings. Whilst a number of studies (22) investigated links between repetition and CTS, a high percentage of studies (36%) failed to find a positive association. Of the 13 studies investigating the effects of vibration, 11 (85%) showed a positive association. However, none of these findings emanated from cohort studies. There was insufficient evidence of a possible association with psychosocial factors, with only six studies meeting the criteria of this review. For the six individual factors identified, there was conflicting evidence of an association with CTS.

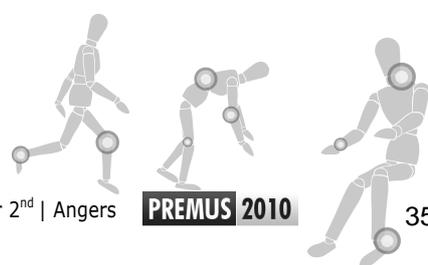
### Conclusion:

There is substantial evidence to support awkward postures as a risk factor for CTS. Surprisingly few high quality studies have investigated a relationship between psychosocial risk factors and CTS. Findings from this work will provide a framework for the development of a decision making tool to determine the work-relatedness of CTS.

**Keywords:** Epidemiology, Carpal tunnel syndrome, Prognosis of MSD

### References:

- Bernard, B. (Ed.). (1997). *Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*. Cincinnati: NIOSH.
- Hayden, J A, Cote, P, Bombardier, C. Evaluation of the quality of prognosis studies in systematic reviews. *Ann Intern Med*. 2006;144(6):427-437.
- Palmer, K. T., Harris, E. C., & Coggon, D. (2007). Carpal tunnel syndrome and its relation to occupation: a systematic review. *Occupational Medicine-Oxford*, 57, 57-66.



## PREDICTORS OF CARPAL TUNNEL SYNDROME (CTS) AMONG NEWLY HIRED WORKERS

FRANZBLAU A.<sup>1</sup>, DALE A.M.<sup>2</sup>, D'ARCY H.<sup>1</sup>, EVANOFF B.<sup>2</sup>

<sup>1</sup> University of Michigan, Ann Arbor, Michigan, USA – <sup>2</sup> Washington University in St. Louis, St. Louis, Missouri, USA

### Aims:

To assess the impact of baseline personal characteristics and job exposures, and the interaction of nerve function and job exposures, on future risk of CTS.

### Methods:

Newly-hired workers (n=1107) from multiple employers and industries were studied at baseline and followed-up at 6, 18 and 36 months. Baseline assessments included: age, gender, BMI, hand dominance, prior medical conditions (diabetes mellitus (DM), rheumatoid arthritis (RA), CTS), job category, hand diagrams, and dominant hand distal median sensory latency (DMDSL). Follow-up included hand diagrams and whether there had been a physician diagnosis of CTS in the follow-up interval. Hand diagrams were scored positive/negative for CTS as previously described (Franzblau et al., 1994).

### Results:

After exclusion of persons with prior DM, RA, and CTS, there were 1070 subjects. Because of small numbers, jobs were grouped into three broad categories that were used as exposure surrogates: construction/trades (42%; floorlayers, sheetmetal workers, carpenters), computer/technical (35%; computer technicians, clerical, health technicians), and service (23%; food service, housekeeper). Multiple logistic regression models predicting a positive dominant hand diagram at 6, 18, and 36 months included the following covariates: age, BMI, gender, 'dummy' variables for job categories (Trades and Service), and baseline DMDSL. BMI (odds ratios (ORs) = 1.08, 1.09 and 1.07 per unit of BMI) and DMDSL (ORs = 2.9, 1.8 and 1.9 per millisecond increase of latency) were highly significant in all models (6, 18 and 36 months of follow-up, respectively). Job category variables were not significant at 6 and 18 months, but both became significant at 36 months (ORs = 4.1 and 2.9 for trades and service compared to computer/technical, respectively). Interaction terms (DMDSL x Trades, DMDSL x Service) were not significant in any models.

A model that examined physician diagnosis of CTS at any time during the 36 months showed similar significant effects for BMI (OR = 1.1 per unit of BMI) and DMDSL (OR = 2.5 per millisecond increase of latency), but job categories were not significant. This model had less power since there were fewer outcomes.

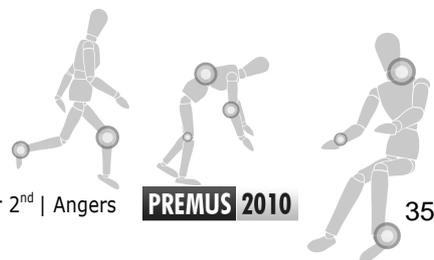
### Conclusion:

Discussion/Conclusion: BMI and DMDSL were significant predictors of having positive hand diagrams at all follow-up time points. Job category was also important, but the effect of job category only became significant after greater elapsed time. There was no interaction between nerve function and job category.

**Keywords:** Personal risk factors for MSD, Epidemiology, Carpal tunnel syndrome

### Reference:

Franzblau A, Werner RA, Albers JW, Grant CL, Olinski D, Johnston E. Workplace surveillance for carpal tunnel syndrome using hand diagrams. *J Occup Rehab.* 1994;4(4):185-198.



## PREVALENCE OF CARPAL TUNNEL SYNDROME AND ABNORMAL MEDIAN NERVE CONDUCTION AT TIME OF HIRE

ROSECRANCE J.C.

*Occupational and Environmental Health Section, Colorado State University, USA*

### **Aims:**

To determine the prevalence of abnormal median nerve conduction and carpal tunnel syndrome among newly hired workers.

### **Methods:**

Workers hired in jobs classified as food manufacturing (North American Industry Classification System) were administered a questionnaire that was designed to elicit general information on age, height, weight, and past and current medical conditions. Additionally, a hand symptom survey assessing the symptoms of numbness, tingling, pain, and burning was administered. Nerve conduction studies of the median nerve through the carpal canal were performed bilaterally on all new employees. If the median nerve latency was greater than 2.4 ms the ulnar nerve latency was assessed in the same hand. Median mononeuropathy was defined as a peak median-ulnar latency difference of 0.6 ms or greater. If a median mixed nerve latency was not obtained an 8 cm median motor orthodromic latency greater than 4.7 ms was used as the criterion for median neuropathy. The surveillance case definition for CTS consisted of the presence of hand symptoms characteristic of CTS and nerve conduction studies indicating a median mononeuropathy across the carpal canal.

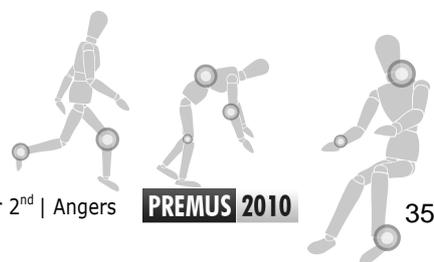
### **Results:**

Over a two-year period (2008 & 2009) 1679 newly hired workers (518 females, 1161 males) from one company were evaluated. Participation rate was 100% since the nerve conduction screening was part of the mandatory new hire process. The mean age (s.d.) of the workers was 32.3 years (11.9) for men and 32.5 years (11.5) for women. Mean (s.d.) body mass index was 28.6 (6.6) for men and 30.5 (7.8) for women. The prevalence of median mononeuropathy among men was 11.8% and 9.0% in the right and left hands, respectively. And among women the prevalence of median mononeuropathy was 19.5% and 16.6% in the right and left hands, respectively. Among the newly hired workers, only 2 women and 6 men that had a median mononeuropathy indicated that they also had symptoms consistent with CTS.

### **Conclusion:**

Many workers at the time of hire appear to have objective evidence of abnormal median nerve conduction within the carpal canal. Few workers at the time of hire report characteristic CTS symptoms, including those with median mononeuropathy. Workers at the time of hire may not be forthcoming with regard to symptoms that indicate existing physical disorders. Alternatively, the threshold for electrophysiological evidence supporting an epidemiological case definition of CTS may need to be reconsidered.

**Keywords:** Surveillance, Epidemiology, Carpal tunnel syndrome



## THE ASSOCIATIONS OF CARDIOVASCULAR RISK FACTORS, CAROTID INTIMA-MEDIA THICKNESS AND MANIFEST ATHEROSCLEROTIC VASCULAR DISEASE WITH CARPAL TUNNEL SYNDROME

SHIRI R., HELIÖVAARA M., MOILANEN L., VIKARI J., LIIRA H., VIKARI-JUNTURA E.

*Finnish Institute of Occupational Health, Helsinki, Finland*

### Aims:

Previous studies suggest associations between cardiovascular risk factors and carpal tunnel syndrome (CTS). The role of atherosclerosis in CTS has not, however, been addressed in population studies. The aim of this study was to investigate the associations of cardiovascular risk factors, carotid intima-media thickness (IMT), and clinical atherosclerotic vascular diseases with CTS.

### Methods:

The target population consisted of subjects aged 30 years or older participating in a national Finnish Health Survey during 2000-2001. Of the 7,977 eligible subjects, 6,254 (78.4%) were included in the study. CTS and pre-existing vascular diseases were diagnosed clinically. Carotid IMT was measured with high-resolution B-mode ultrasound imaging.

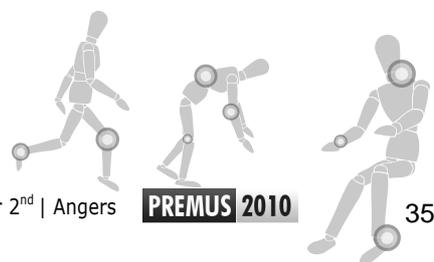
### Results:

Obesity (adjusted odds ratio (OR) 2.4, 95% confidence interval (CI) 1.1-5.4), high LDL cholesterol (OR 3.8, 95% CI 1.6-9.1 for >190 vs. <129 mg/dL), high triglycerides (OR 2.7, 95% CI 1.2-6.1 for >200 vs. <150 mg/dL), hypertension (OR 3.4, 95% CI 1.6-7.4) and arrhythmia (OR 10.2, 95% CI 2.7-38.4) were associated with possible/probable CTS in subjects aged 30-44 years. In the age group of 60 years or older, coronary artery disease (OR 1.9, 95% CI 1.1-3.5), valvular heart disease (OR 2.3, 95% CI 1.0-5.0) and carotid IMT (1.4, 95% CI 0.9-2.1 for each 0.23 mm increase) were associated with CTS. Carotid IMT was associated with CTS only in subjects with hypertension (OR 1.7, 95% CI 1.1-2.6), or clinical atherosclerotic vascular disease (OR 2.1, 95% CI 1.1-4.2), or in those who were exposed to physical work load factors.

### Conclusion:

Our findings suggest associations of cardiovascular risk factors with CTS in young people, and with carotid IMT and clinical atherosclerotic vascular disease in older people. CTS may be a manifestation of atherosclerosis, or both conditions may share similar risk factors.

**Keywords:** Personal risk factors for MSD, Epidemiology, Carpal tunnel syndrome



## HIGH HERITABILITY FOR CONCURRENT LOW BACK AND NECK-SHOULDER PAIN – A STUDY OF TWINS

NYMAN T., MULDER M., ILIADOU A., SVARTENGREN M., WIKTORIN C.

*Department of Public Health Sciences, Division of Occupational and Environmental Medicine, Karolinska Institutet, Stockholm, Sweden*

### Aims

To investigate the importance of genetic factors for the occurrence of “Concurrent low back (LBP) and neck-shoulder pain (NSP)” as well as of “Solely LBP”, and “Solely NSP” in an adult population of women and men.

### Methods:

Data on 20946 monozygotic (MZ) and dizygotic (DZ) twins, born 1959-1985, was obtained from a cross-sectional study, performed in 2005-2006 and administered by the Swedish Twin Registry. Heritability of “Concurrent LBP and NSP”, “Solely LBP”, and “Solely NSP” was analysed in 2934 MZ twin pairs, 2009 same-sex DZ twin pairs, and 1960 opposite-sex DZ twin pairs without any known rheumatic disorders using structural equation modeling (SEM).

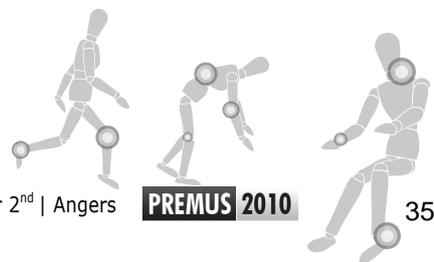
### Results:

The structural equation modeling showed that 60% of the total variance for “Concurrent LBP and NSP” can be explained by additive genetic effects, which was twice as large as for “Solely LBP” (30%) and more than twice as large as for “Solely NSP” (24%). The sex-limitation analyses concluded that the same genes were present in women and men and that there were no differences regarding the size of the additive genetic effects. The effects of common environmental factors (C) were negligible in the present study.

### Conclusion:

Genetic factors had a considerably greater importance for the occurrence of “Concurrent LBP and NSP” compared to “Solely LBP” or “Solely NSP”. The influence of genetic factors was similar for “Solely LBP” and “Solely NSP”. In a clinical view, possible etiological differences for “Concurrent LBP and NSP” compared to for “Solely LBP” and “Solely NSP” may influence the choice of treatment and the prognosis of these disorders. The findings in this study suggest that when research on LBP or NSP is performed, it is important to take into consideration any concurrent pain from the other spinal area.

**Keywords:** Epidemiology, Back, low back, Neck



## IMPROVING THE CLASSIFICATION OF UPPER LIMB DISORDERS

PALMER K.T., COGGON D.

MRC Epidemiology Resource Centre, University of Southampton, UK

### Aims:

The optimum classification of upper limb disorders (ULDs) remains uncertain, as evidenced by a multiplicity of diagnostic labels and approaches, and the want of a gold standard. Expert panels have attempted to agree consensual criteria, but so great is disagreement that a systematic review identified 27 schemes of which no two were identical [1]. An empirical way forward may be to exploit the utilitarian view of diagnosis, as an aid to improved clinical care and/or prevention [2]. According to this view, useful case definitions will distinguish groups differing in their response to treatment and/or the strength of their association with potential causes: 'added value' will provide a rationale for preferring one approach over another. This study explores whether utilitarian data can lead to better consensus on appropriate classification of ULDs.

### Methods:

A systematic review and consultation is being undertaken in stages. Search 1 will explore the provenance of current schemes and the data-driven evidence supporting their use. Search 2 combines terms for ULD with those for treatment or physical risk factors for ULDs to identify the case definitions employed in studies which demonstrate effective response to treatment or clear-cut associations with risk factors (case definitions that 'add value' empirically). A summary of findings on schemes and their utility will be presented to expert consultees (some 14 researchers from 7 countries), together with a set of principles developed as a basis for scheme selection. Consultees' views will be harvested using a structured pro-forma. Responses will be summarised and re-presented to participants in a modified Delphi approach.

### Results:

We will subject our broadly based reviews to peer discussion and critique, and engage the academic community in structured debate. The aim will be to agree a rational framework for ULD classification, or at the least, clarify points of difference and principle. By involving many leading international research experts in the field we hope to develop a practical consensus, capable of promoting the future pooling of research data. Findings will be presented at the meeting.

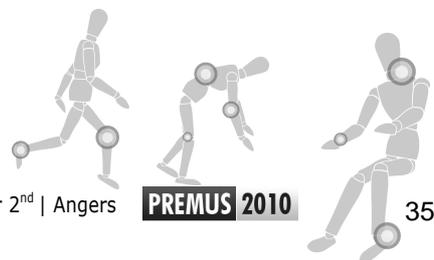
### Conclusion:

The want of an agreed system has adverse consequences. Importantly, it erodes the pooling of research observations, makes the research literature difficult for policy makers and practitioners to interpret, impedes the surveillance of occupationally-related MSDs, and leads to large variations in clinical practice. A data-driven utilitarian consensus may promote greater consensus and resolve the current impasse.

**Keywords:** Methods in epidemiology, Upper limb

### References:

Van Eerd D, Beaton D, Cole D, Lucas J, Hogg-Johnson S, Bombardier C. Classification systems for upper-limb musculoskeletal disorders in workers: a review of the literature. *J Clin Epidemiol* 2003;56:925-936.  
Coggon D, Martyn C, Palmer KT, Evanoff B. Assessing case definitions in the absence of a diagnostic gold standard. *Intl J Epidemiol* 2005; 34: 949-952.



## CLASSIFYING NON-SPECIFIC UPPER EXTREMITY MUSCULOSKELETAL DISORDERS BY CLUSTER ANALYSIS: COMING TO A SOLUTION?

GOLD J.E., PILIGIAN G., GLUTTING J.J., HANLON A., FRINGS-DRESEN M.H.W., SLUITER J.K.

Temple University, Philadelphia, Pennsylvania, USA; Academic Medical Center, Coronel Institute of Occupational Health, Amsterdam, The Netherlands

### Aims:

Unlike localized and defined disorders such as CTS, epicondylitis, and de Quervain's, some upper extremity musculoskeletal complaints are not readily classified. The study objective was to determine if there were symptom patterns in self-identified RSI patients. It was hypothesized that distinct UEMSD syndromes would be identified based on localization of symptoms affecting each of: hand/wrist, elbow/forearm, shoulder/upper arm, neck. It was further hypothesized that discrimination of syndromes within each of these regions would be distinguished by present quality of symptoms (pain, stiffness, etc.) and by intensity of patient complaint.

### Methods:

Members (N = 700) of the Dutch RSI Patients Association filled out a detailed symptom questionnaire. Intensity of symptom quality (e.g., dull aching or burning pain, stiffness, paraesthesias, numbness, and coldness) in eleven anatomical regions, symptom duration in the last week by body region, and symptom severity in the upper extremity during the last week (118 variables in total) were candidates for factor analysis. Principal components analysis uncovered 14 dimensions. The dimensions were submitted to cluster analysis using both Ward's minimum-variance procedure (stage 1) and a k-means algorithm (stage 2).

### Results:

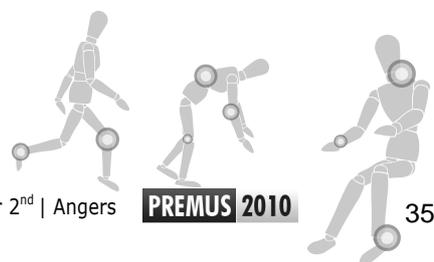
Sixty-six percent of the cohort (n = 462) was female, with mean age 37.6 years and mean symptom duration 39 months. 60% were working at least part-time. 46% listed their occupation as "administrative activities/office work." IT and industrial workers each comprised ~15% of respondents.

Eight clusters, based largely on symptom severity and quality, were classified. All but one cluster showed diffuse symptoms; the exception was bilateral symptoms of stiffness and aching pain in the shoulder/neck. The largest cluster (n = 265) was characterized by mild diffuse symptoms of relatively short duration (mean = 2.5 years). Two clusters with respondents reporting the greatest intensity of complaints were distinguished by symptom quality; either pain or coldness/numbness/paraesthesias predominated.

### Conclusion:

Eight distinct clusters comprised of UEMSD symptoms were classified from in a dataset of RSI patients. Seven of the clusters were distinguished by severity and quality, rather than locality, of symptoms. Diagnostic categories which localize upper extremity musculoskeletal disorders to a specific anatomical area may be inadequate. Future clustering studies should rely on both signs and symptoms. Data could be collected from health care providers prospectively to determine the possible prognostic value of the identified clusters with respect to natural history, chronicity, and return to work.

**Keywords:** Epidemiology, Upper limb, Prognosis of MSD



## EPICONDYLITIS RELATED TO WORK EXPOSURES OF FORCE, REPETITION, AND POSTURE

JAEGERS L.A., DALE A.M., EVANOFF B.

*Interventions LLC, Defiance, Missouri, USA - Division of General Medical Sciences, Washington University School of Medicine, St. Louis, Missouri, USA*

### Aims:

To evaluate the association between physical work exposures of hand force, hand repetition, and wrist posture to medial or lateral epicondylitis of the elbow.

### Methods:

Newly-hired workers (n=1,107) recruited from several industries underwent focused upper extremity physical exams at baseline and 36 months and completed questionnaires at baseline, 6, 18, and 36 months. Questionnaires provided information on personal factors (age, gender), hand/arm symptoms, job title, and work exposures. Observed work exposures on a subset of this cohort used videotaped samples of work tasks to obtain ratings of hand force (peak), hand activity level, and wrist posture on 452 subjects at 6 and 36 months.

Our case definition of epicondylitis included 1) discomfort during palpation or resisted maneuvers of the elbow from physical exam (positive sign) AND 2) report of elbow or wrist symptoms for two different time frames: current symptoms and symptoms in the past year (1). Logistic regression multivariate analyses evaluated the association of observed work exposures to cases of epicondylitis after controlling for age, gender, and body mass index (BMI).

### Results:

Of the 255 subjects with complete data, 27 (10.6%) cases reported elbow or wrist/hand symptoms in the past year and positive signs on physical exam of the elbow and 19 (7.5%) had current symptoms and positive signs of the elbow. Subjects worked in several industries: construction (n= 123), service (n= 41), clerical/computer (n= 45), and laboratory/health care (n=46). Physical exposures were entered individually into models adjusting for age, gender, and BMI, and showed significant associations with epicondylitis. For the case definition requiring symptoms in the past year, significant associations were found for peak hand force (OR=1.3, 95% CI=1.0-1.8), hand activity level (OR =1.5, 95% CI=1.0-2.2), and ACGIH HAL-TLV (OR=5.7, 95% CI=1.4-23.8). There was no association with wrist posture. Similar results were found using a case definition of current symptoms and physical signs, and for symptoms alone.

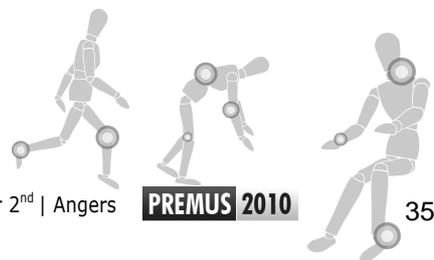
### Conclusion:

Hand force and hand activity level, but not wrist posture, were associated with epicondylitis in our study, which had relatively few cases. The highest odds ratio was seen for a combination of force and repetition using the HAL-TLV. Few prospective studies have examined epicondylitis among workers. Similar to other studies (2), our findings support the relationship of work exposures and the diagnosis of epicondylitis.

**Keywords:** Postures, physical exposure, Upper limb, Other.

### References:

Sluiter JK, Rest KM, Frings-Dresen MHW. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. *Scand J Work Environ Health*. 2001;27suppl:1-102.  
Fan ZJ, Silverstein BA, Bao S, Bonauto DK, Howard NL, Spielholz PO, et al. Quantitative exposure-response relations between physical workload and prevalence of lateral epicondylitis in a working population. *Am J Ind Med*. 2009;52:479-90.



## ULNAR NEUROPATHY-LIKE SYMPTOMS WITH NEGATIVE ELECTRONEUROGRAPHY IN RELATION TO MECHANICAL EXPOSURES ASSESSED BY A JOB EXPOSURE MATRIX: CASE-REFERENT STUDY

FROST P., SVENDSEN S.W., JOHNSEN B., FUGLSANG-FREDERIKSEN A.

Danish Ramazzini Center, Department of Occupational Medicine, Aarhus University Hospital, Aarhus, Denmark, 2Danish Ramazzini Center, Department of Occupational Medicine, Regional Hospital West Jutland, Herning, Denmark, 3Department of Neurophysiology, A

### Aims:

We have recently documented associations between ulnar neuropathy and occupational mechanical exposures<sup>1</sup>). The question remains whether this reflects specific effects on the ulnar nerve or non-specific associations with tingling and numbness in the hand. To address this question, we aimed to identify and quantify relations between occupational mechanical exposures and ulnar neuropathy-like symptoms with negative results of electroneurography (ENG), while adjusting for probable confounders.

### Methods:

From the Danish National Patient Register we extracted all patients referred to the Department of Neurophysiology in Aarhus on suspicion of ulnar neuropathy, 1 March 2001 to 30 June 2007, whose ENG-examination included the elbow, but whose ENG-results did not fulfil criteria for ulnar neuropathy. Restriction was made to patients 18-65 year old at the time of examination. After exclusion due to death, emigration, address protection, and protection against inquiries in connection with scientific studies, we mailed a questionnaire to 453 cases and 1204 community referents matched on sex, 5-year age categories, and primary care centre.

We constructed a Job Exposure Matrix (JEM) comprising 169 job groups with quantitative estimates obtained by averaging five experts' ratings. We extracted individual exposure estimates from the JEM based on self-reported job title for the year before the matching date (ENG-date of the cases) on repetitive work, non-neutral postures of elbow or wrist, use of handheld vibrating tools with acceleration levels  $\geq 3$  m/s<sup>2</sup> (all assessed as time per day in ½ hour intervals), and forceful work (score 1-5). We used conditional logistic regression for analyses

### Results:

The proportion who responded was 63% and 56% among cases and referents, respectively. Preliminary multivariate analyses including one mechanical exposure variable at a time showed exposure-response patterns for all exposures studied. When combined into one model, ORs of 1.5 (0.8-2.8) were observed for repetitive (yes/no) but not forceful work (score 1 vs  $\geq 2$ ), 1.5 (0.8-2.9) for non-repetitive but forceful work, and 1.6 (0.9-2.5) for repetitive and forceful work - non-neutral postures and hand-arm vibrations did not retain their significance, either.

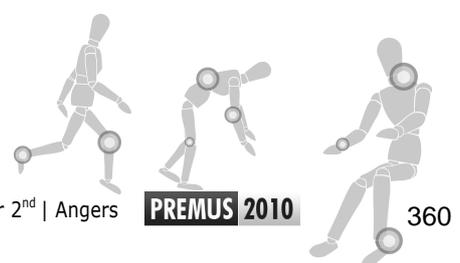
### Conclusion:

The study benefitted from independent exposure assessment using a job exposure matrix based on expert ratings. Mechanical exposures played a weaker role for ulnar neuropathy-like symptoms with negative ENG than for ulnar neuropathy verified by ENG. This seems to suggest specific effects of mechanical exposures on the ulnar nerve

**Keywords:** Personal risk factors for MSD, Upper limb, Specific health outcomes

### References:

Svensden SW, Frost P, Johnsen B, Fuglsang-Frederiksen A. Ulnar neuropathy in relation to mechanical exposures assessed by a job exposure matrix: case-referent study. Abstract submitted for PREMUS 2010, 7th International Scientific Conference on Prevention of Work-related Musculoskeletal Disorders, Angers, France, 29/08/ - 03/09/10.



## ULNAR NEUROPATHY IN RELATION TO MECHANICAL EXPOSURES ASSESSED BY A JOB EXPOSURE MATRIX: CASE-REFERENT STUDY

SVENDSEN S.W., FROST P., JOHNSEN B., FUGLSANG-FREDERIKSEN A.

(1) Danish Ramazzini Center, Department of Occupational Medicine, Regional Hospital West Jutland, Herning, Denmark. (2) Danish Ramazzini Center, Department of Occupational Medicine, Aarhus University Hospital, Aarhus, Denmark. (3) Department of Neurophysi

### Aims:

Evidence is sparse of the work-relatedness of ulnar neuropathy. We aimed to identify and quantify relations between occupational mechanical exposures and ulnar neuropathy, adjusting for probable confounders.

### Methods:

From the Danish National Patient Register we extracted all patients diagnosed with ulnar neuropathy at the Department of Neurophysiology in Aarhus, 2001-2007. This group was restricted to patients aged 18-65 years at the time of diagnosis, whose electroneurographic examination (ENG) included the elbow, and whose ENG-results fulfilled specified criteria. After exclusion due to death, emigration, address protection, and protection against inquiries in connection with scientific studies, we mailed a questionnaire to 726 cases and 1909 community referents matched on sex, 5-year age categories, and primary care centre (risk set sampling).

We constructed a Job Exposure Matrix (JEM) comprising 169 job groups with quantitative exposure estimates obtained by averaging five experts' ratings. For each participant, we extracted exposure estimates from the JEM based on his/her self-reported job title for the year before the matching date (ENG-date of the cases). We focussed on repetitive work, non-neutral postures of elbow/wrist, use of handheld vibrating tools with acceleration levels  $\geq 3$  m/s<sup>2</sup> (all assessed as time per day in ½ hour intervals), and forceful work (score 1-5). We used conditional logistic regression, adjusting for fractures, smoking, alcohol consumption, and BMI.

### Results:

The proportion who responded was 60% and 59% among cases and referents, respectively. A force score  $\geq 2$  was assigned to 54.7% of cases versus 38.3% of referents. The corresponding percentages were 47.8% and 35.4% for repetitive work  $\geq 1/2$  hour/day. Preliminary multivariate analyses including one mechanical exposure variable at a time showed exposure-response patterns for all exposures studied. When combined into one model, ORs of 1.3 (1.2-3.2) were observed for repetitive (yes/no) but not forceful work (1 versus  $\geq 2$ ), 1.9 (1.2-3.2) for non-repetitive but forceful work, and 2.0 (1.2-3.1) for repetitive and forceful work - other mechanical exposures did not retain their significance.

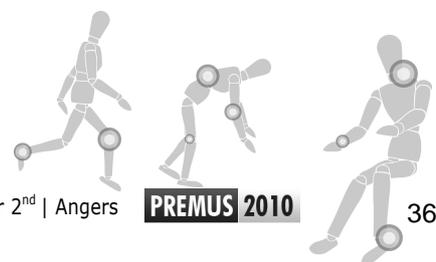
### Conclusion:

The study benefitted from independent exposure assessment using a job exposure matrix based on expert ratings. Our findings suggested that ulnar neuropathy may be related to repetitive and forceful work, with force requirements seeming to be of major importance. Whether the associations reflect specific effects on the nerve will be addressed by studying ulnar neuropathy-like symptoms without confirmative ENG-results (1).

**Keywords:** Personal risk factors for MSD, Upper limb, Specific health outcomes

### Reference:

Frost P, Svendsen SW, Johnsen B, Fuglsang-Frederiksen A. Ulnar neuropathy-like symptoms with negative electroneurography in relation to mechanical exposures assessed by a job exposure matrix: case-referent study. Abstract submitted for PREMUS 2010, 7th International Scientific Conference on Prevention of Work-related Musculoskeletal Disorders, Angers, France, 29/08/ - 03/09/10.



## WORK-RELATED LESIONS OF THE SUPRASPINATUS TENDON – A CASE-CONTROL STUDY

SEIDLER A., BOLM-AUDORFF U., PETEREIT-HAACK G., ELSNER G.

*Federal Institute of Occupational Safety and Health, Berlin, Germany*

### **Aims:**

To examine the dose-response-relationship between cumulative duration of work with highly elevated arms (work above shoulder level) as well as of manual material handling and ruptures of the supraspinatus tendon in a population-based case-control study.

### **Methods:**

In 15 radiologic practices we recruited 483 male patients aged 25 to 65 with radiographically confirmed partial (n=384) or total (n=98) supraspinatus tears associated with shoulder pain. A total of 300 male control subjects were recruited. Data were gathered in a structured personal interview. To calculate cumulative exposure, the self-reported duration of lifting/carrying of heavy loads (> 20 kg) as well as the duration of work with highly elevated arms was summed up over the entire working life.

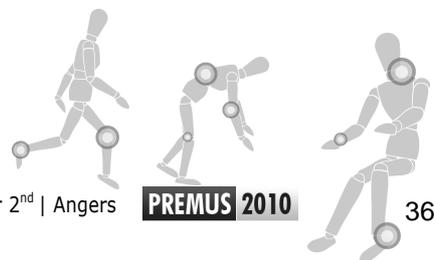
### **Results:**

The results of our study support a dose-response relationship between cumulative duration of work with highly elevated arms and symptomatic supraspinatus tendon tears. For a cumulative duration of > 3,195 hours work above shoulder level the risk of a supraspinatus tendon rupture is elevated to 2.0 (95% CI 1.1-3.5), adjusted for age, region, lifting/carrying of heavy loads, handheld vibration, apparatus gymnastics/shot put/javelin/hammer throwing/wrestling, and tennis. The cumulative duration of carrying/lifting of heavy loads also yields a positive dose-response relation with disease (independent from work above shoulder level and from handheld vibration), with an adjusted odds ratio of 1.8 (95% CI 1.0-3.2) in the highest exposure category (>77 hours). We find an increased risk for subjects exposed to handheld vibration with an adjusted OR of 3.2 (95% CI 1.7-5.9) in the highest exposure category (16 years or more on the exposed job), but a clear dose-response relationship is lacking.

### **Conclusion:**

This study points to a potential etiologic role of long term cumulative effects of work with highly elevated arms and heavy lifting/carrying to shoulder tendon disorders.

**Keywords:** Postures, physical exposure, Epidemiology, Upper limb.



## MECHANICAL DETERMINANTS OF CARPAL TUNNEL SYNDROME IN A POPULATION OF THE COLOMBIAN FLOWER INDUSTRY

BARRERO L.H., QUINTANA L.A., CEBALLOS C., VILLALOBOS G., PIEDRAHITA H.H., PULIDO J.A., NOKHBEZAIM M., HOEHNE-HUECKSTAEDT U., ELLEGAST R.P.

Javeriana University, Bogotá, Colombia

### Aims:

Carpal tunnel syndrome (CTS) is the most frequently recorded occupational disease in Colombia.[1] The flower industry has been mainly affected, with annual incidences that are over 500 cases per 100,000 workers in recent years. However, little is known about the means that would contribute to CTS prevention. We aimed to assess the mechanical determinants of CTS in a population of Colombian workers.

### Methods:

In this cross-sectional study, 160 workers (mean age 35.7, SD=8.9) from eight flower manufactures were recruited. There were three levels of data collection. First, all workers were interviewed about demographics, tasks' durations and effort associated with those tasks; also, physical examinations allowed determining a medical impression for the presence of CTS (CTSMI).[2] Second, 80 workers were observed to estimate the Job Strain Index for the workers' main job task, cutting, packing or a combination of those tasks. Third, upper-extremity kinematics of 40 workers were assessed using the CUELA system.[3] Variables tested for association with CTSMI included demographics, effort, and mechanical demands derived from observations and direct measurements. Generalized estimating equations were used to estimate CTSMI prevalence and multivariable models.

### Results:

Prevalence of CTSMI was 33.1%. In the adjusted analyses only effort at work was significantly associated with CTSMI (Table 1). Differences in occurrence of CTSMI by task were mostly explained by gender and effort. Further adjustments indicated that median velocity of the hand in the flexion-extension and ulnar-radial directions; and the mean elbow flexion relate to CTSMI and explain residual differences in CTSMI occurrence by task.

Table 1. Determinants of occurrence of medical impression for CTS

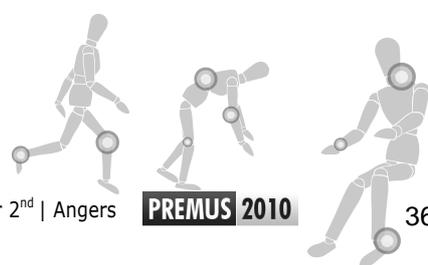
Variable	Unadjusted OR 95% CI	Adjusted† OR 95% CI
Age (years)		
≤30	0.5 (0.2-1.2)*	2.3 (0.5-11.9)
>30-≤40	1.2 (0.5-2.6)	3.1 (1.4-6.9)
>40-≤50	1.0 (0.6-1.5)	1.5 (0.6-3.4)
>50		
Gender		
Female	2.7 (1.4-5.6)*	2.6 (1.1-6.0)
Male	1	1
BMI (Kg/m <sup>2</sup> )	1.0 (1.0-1.1)*	1.0 (0.9-1.0)
Job seniority	1.1 (1.1-1.1)*	1.1 (1.0-1.2)
Smoking in life		
Current	0.8 (0.2-2.4)	
Ever	0.8 (0.3-2.5)	NA
Never	1	
# cigarettes in life time (x 1000 cigarettes)	1.0 (1.0-1.0)*	-
Time out of the workplace in somewhat heavy activities‡	1.0 (1.0-1.1)*	-
Time-weighted effort out of the workplace‡	1.0 (0.7-1.3)	NA
Task	0	
Cutting	1.3 (1.0-1.8)*	-
Packing	2.4 (1.2-5.0)*	-
Combined task	1	-
Time in the workplace in somewhat heavy activities‡	1.0 (1.0-1.0)*	-
Time-weighted effort in the workplace‡	1.5 (1.1-2.0)*	1.5 (1.1-1.9)
Job strain index	1.0 (0.8-1.1)	NA

Statistically significant results in bold letters;

\* Variables with significance below 0.5 were considered in the adjusted models

† Model adjusted for age, gender, body mass index and job experience

‡ Effort was assessed using a 6-20 Borg scale.



**Conclusion:**

CTSMI occurrence is high in this population and is partly explained by work mechanical demands. Positive associations of hand velocity-related variables and elbow flexion with CTSMI suggest that interventions should be oriented to reduce work pace and increase work breaks.

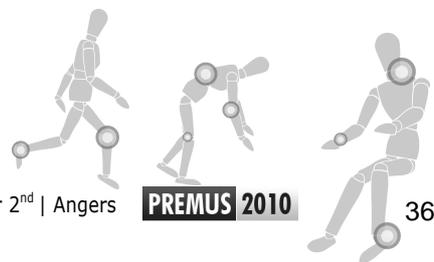
**Keywords:** Agriculture, Epidemiology, Upper limb

**References:**

Tafur, F.J., Informe de enfermedad ocupacional en Colombia 2003-2005, ed. Ministerio de la Protección Social. 2007, Bogotá: Imprenta Nacional de Colombia.

Polo, B.E., et al., Guía de Atención Integral Basada en la Evidencia para Desórdenes Musculoesqueléticos (DME) relacionados con Movimientos Repetitivos de Miembros Superiores (Síndrome de Túnel Carpiano, Epicondilitis y enfermedad de De Quervain (GATI-DME), Ministerio de la Protección Social, Editor. 2006: Bogotá.

Ellegast, R.P. and et al., Workload Assessment in Field Using the Ambulatory CUELA System, in Digital Human Modeling HCII. 2009, V.G. Springer: Berlin 2009. p. 221-226.



## MUSCULOSKELETAL SYMPTOMS AMONG MOBILE HAND HELD DEVICE USERS AND THEIR RELATIONSHIP TO DEVICE USE: A PRELIMINARY STUDY IN A CANADIAN UNIVERSITY POPULATION

BEROLO S., WELLS R., AMICK B.C.

BEROLO, S., University of Waterloo, Waterloo, Canada; WELLS, R.P., University of Waterloo, Waterloo, Canada; AMICK III, B.C., Institute for Work and Health, Toronto, Canada

### Aims:

The aims of this study were to: 1) determine the distribution of seven measures of mobile device use among a population of university students, staff, and faculty, 2) determine the distribution of musculoskeletal symptoms of the upper extremity, upper back and neck among a population of university students, staff, and faculty and 3) assess the relationship between measures of mobile device use and musculoskeletal symptoms among this population.

### Methods:

Using cross-sectional design, an internet-based questionnaire was used to collect self-reported measures of daily mobile hand held device use and self-reported symptoms of pain in the upper extremity, upper back, and neck in 140 students, faculty and staff at a Canadian university. A dichotomous exposure variable (low/high) was created for each of the six measures of mobile device use collected in the questionnaire as well as for total device use. Pain data collected in the questionnaire was dichotomized to “no pain” (0 on Likert scale) or “any pain” (1 to 10 Likert scale). By controlling for covariates (daily computer/laptop keyboard and mouse use, daily game controller use, university status (faculty, staff or student) and gender) multivariate logistic regression was used to examine the relationship between seven dichotomous mobile device use exposure variables and 24 dichotomous outcomes.

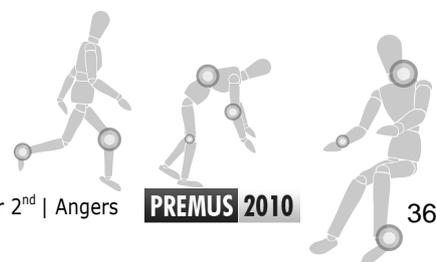
### Results:

137 of 140 participants (98%) reported using a mobile device. The mean time these individuals spent using their device(s) on a typical day was 4.65 hrs (SD 5.67). Most participants (84%) reported pain of any severity in at least one body part. Pain in the right hand was most prevalent at the base of the thumb (17% reporting slight pain, 9% reporting moderate pain, 2% reporting severe pain). Total time spent using a mobile device was significantly associated with any pain reported in the left shoulder (OR = 2.06; 95% CI 1.00 to 4.24), the right shoulder (OR = 2.55; 95% CI 1.25 to 5.21), and the neck (OR = 2.72; 95% CI 1.24 to 5.96).

### Conclusion:

Although this research is preliminary, the associations observed between measures of mobile device use and musculoskeletal symptoms, in combination with the rising use of mobile hand held devices, argues for further research in this field including a prospective study with more well-validated exposure measures.

**Keywords:** Epidemiology, upper limb, other



## HAS MANUAL REPETITIVE WORK AN ACUTE EFFECT ON MEDIAN AND ULNAR NERVE CONDUCTION PARAMETERS?

BONFIGLIOLI R., CALABRESE M., GRAZIOSI F., MARINELLI F., MUSSONI P., VIOLANTE F.S.

Section of Occupational Medicine - Department of Internal Medicine, Geriatrics and Nephrology, Alma Mater Studiorum University of Bologna, Bologna, Italy

### Aims:

To assess if repetitive manual work exerts instant influence on nerve conduction parameters at the wrist and forearm.

### Methods:

Twenty-eight volunteers employed in administrative duties were selected through a standardized questionnaire to exclude hand symptoms indicative of carpal tunnel syndrome. All participants underwent median and ulnar nerve conduction study (NCS) of the dominant limb at the end of the interview (T0), after a 30-minute rest in sitting position (T1) and after performing a standardized manual task in sitting or standing position for one hour and a half (T2). The task was designed to simulate typical assembly and packing activities. Overall, the combination of hand activity and force was just below ACGIH-TLV reference values. Room and skin temperature (°C) were monitored.

### Results:

No significant differences were observed for skin temperature and NCS parameters between baseline and 30-minute rest recordings. Significantly higher skin temperature mean values were found after performing the manual task as compared to the previous tests (T0:  $32.9 \pm 1.2$  SD; T1:  $33.1 \pm 1.6$  SD; T2:  $35.1 \pm 0.6$  SD;  $p < 0.01$ ). NCS parameters recorded both at the wrist and forearm improved at the end of the standardized manual task: significantly lower motor and sensory mean latencies and higher mean sensory conduction velocity (SCV mt/sec) values were measured for the median nerve (SCV palm-wrist: T0  $58.7 \pm 5.4$ ; T1  $60.1 \pm 6.6$ ; T2  $63.2 \pm 6.6$ ;  $p$

### Conclusion:

The literature reports the influence of whole body physical exercise on NCS parameters (through body temperature increase) and median nerve conduction impairment due to carpal canal pressure increase.

To our knowledge, data are not available about the acute effect of repetitive hand activity on median NCS parameters at the wrist level; moreover, several epidemiological studies collected data during the work shift.

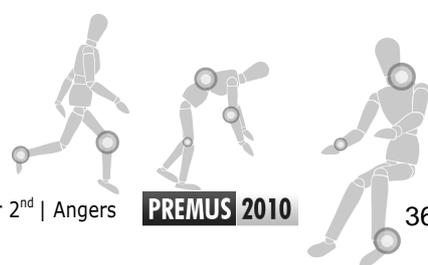
Our hypothesis was to record a worsening of median NCS parameters at the wrist level as a consequence of carpal tunnel pressure increase caused by manual work.

These preliminary results showed a major effect of manual work on skin temperature and an improvement of NCS parameters both in the forearm and in the palm-wrist segment subjected to biomechanical overload. Besides, no differences were recorded between ulnar and median nerve conduction changes at the wrist, although median nerve is considered the most stressed.

**Keywords:** Mechanism of pain and tissue injury, postures, physical exposure, carpal tunnel syndrome.

### References:

- Halar EM, Hammond MC, Dirks S. Physical activity: its influence on nerve conduction velocity. *Arch Phys Med Rehabil.* 1985; 66(9): 605-9
- Lundborg G, Gelberman RH, Minteer-Convery M, Lee YF, Hargens AR. Median nerve compression in the carpal tunnel-- functional response to experimentally induced controlled pressure. *J Hand Surg Am.* 1982 May;7(3):252-9
- Rempel DM, Diao E. Entrapment neuropathies: pathophysiology and pathogenesis. *J Electromyogr Kinesiol.* 2004 Feb;14(1):71-5



## ASSOCIATIONS BETWEEN 3-MONTH PREVALENCE OF NECK PAIN AND RISK FACTORS AMONG UNDERGRADUATE STUDENTS

KANCHANOMAI S., JANWANTANAKUL P., PENSRI P., JIAMJARASRANGSI W.

*Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Thailand*

### Aims:

Neck pain are common among office workers. Adolescents with musculoskeletal symptoms were likely to become adults with such symptoms. Computer use is very common among undergraduate students. Increased computer usage has been linked to a high prevalence of neck pain. Thus, the aim of the present study was to examine risk factors associated with the self-reported, 3-month prevalence of neck pain in undergraduate students.

### Methods:

A cross-sectional survey was conducted using a descriptive questionnaire distributed to 3,243 undergraduate students at a university in Thailand.

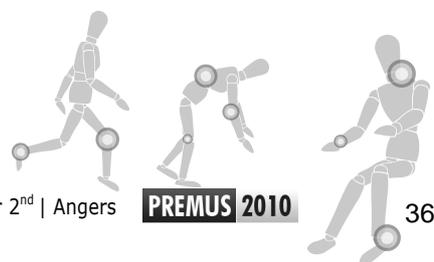
### Results:

A total of 2,302 undergraduate students (71%) completed the questionnaire, of whom 2,275 were eligible for the study. Females, 2nd, 3rd or 4th year students, computer use for >3 hours/day, using keyboard for >70% of working time, self-rated position of keyboard as too low or too high and poor sitting posture and knee position during computer use significantly increased the risk of experiencing neck pain (adjusted odds ratios ranging from 1.38-1.93).

### Conclusion:

Some individual and computer-related factors were associated with the prevalence of neck pain among undergraduate students. Many undergraduate students could be “sick” before they enter the workforce and some may become unhealthy future workers. Consequently, more attention may need to be directed to the younger population to prevent morbidity in adulthood.

**Keywords:** Computer work, Neck, Pain, Chronic pain



## AN EXPERIMENTAL PAIN MODEL FOR LATERAL EPICONDYLALGIA TO ASSESS ITS SENSORY-MOTOR ASPECTS

SAMANI A., FERNANDEZ-CARNERO J., BINDERUP A.T., ARENDT-NIELSEN L., MADELEINE P.

Center for Sensory-Motor Interaction (SMI), Dept. of Health Science and Technology, Aalborg University, Aalborg, Denmark

### Aims:

Lateral epicondylalgia (LE), is one of the most prevalent disorders of upper extremities in the working population. It is especially high among computer workers [1]. Although the pathophysiology is still unknown, there is a general agreement that the extensor carpi radialis brevis muscle most likely plays a relevant role in the development of LE [2]. Additionally, patients with trapezius myalgia frequently report pain referred to the arm extending to the hand and the fingers which highlights the possible interactive mechanism between cervical/ thoracic spine and lateral elbow disorders [3]. In this study, an experimental model to simulate and study sensory motor aspects of LE was developed by inducing experimental pain in trapezius and eccentric exercise of the wrist extensors.

### Methods:

Thirteen right handed healthy men performed four sessions of 10 min computer mouse work over two consecutive days. The first session was performed without inducing pain. Prior and during the second session, the subjects received bolus injections of hypertonic saline in the belly of the right upper trapezius muscle. Sequentially, participants performed five bouts of wrist extension over a total time period of 25 min, at 70% maximum voluntary contraction (MVC) with a 5% MVC decrement per bout to induce delayed onset muscle soreness (DOMS). On the following day, the two other computer sessions were performed similar to the first day. Surface EMG was recorded from flexor carpi ulnaris (FCU), extensor carpi radialis brevis (ECR) and descending part of trapezius on ipsilateral side during all sessions. Pressure pain threshold (PPT) at 12 points forming a 3x4 grid (upper, middle, lower around the lateral epicondyle) was measured at the beginning of first and second day.

### Results:

Presence of pain in trapezius contributed to decrease the EMG amplitude in trapezius and relative rest time in the FCU. This effect of pain on FCU sustained even with the presence of DOMS ( $P < 0.05$ ). DOMS resulted in heterogeneous muscle hyperalgesia. The most sensitive localizations for PPT assessment prior to DOMS were found on the muscle belly of the ECR, which had more pronounced developed mechanical pain hyperalgesia compared to remaining points on the assessed grid.

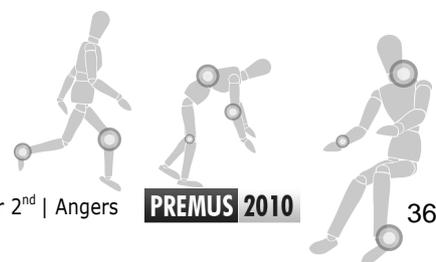
### Conclusion:

The study showed a possible interaction in muscular activity in the shoulder girdle and wrist extensor muscles in presence of pain, which may highlight the existing link between shoulder disorders and LE. It also highlighted heterogeneous deep tissue sensory sensitivity, which can be used as a prognostic tool to assess musculoskeletal disorders.

**Keywords:** Muscle activity, Computer work, Pain, Chronic pain

### References:

- F. Gerr, M. Marcus, C. Ensor, D. Kleinbaum, S. Cohen, A. Edwards, E. Gentry, D. J. Ortiz and C. Monteilh, "A prospective study of computer users: I. Study design and incidence of musculoskeletal symptoms and disorders," *Am. J. Ind. Med.*, vol. 41, pp. 221-235, 2002
- B. O. Ljung, R. L. Lieber and J. Friden, "Wrist extensor muscle pathology in lateral epicondylitis," *Journal of Hand Surgery (British and European Volume)*, vol. 24, pp. 177, 1999
- B. Vicenzino, D. Collins and A. Wright, "The initial effects of a cervical spine manipulative physiotherapy treatment on the pain and dysfunction of lateral epicondylalgia," *Pain*, vol. 68, pp. 69-74, 1996



## PERFORMANCE OF SIMPLIFIED SCORING SYSTEMS FOR HAND DIAGRAMS IN CARPAL TUNNEL SYNDROME SCREENING

CALFEE R.P., DALE A.M., DESCATHA A., FRANZBLAU A., EVANOFF B.

Washington University School of Medicine, St. Louis, MISSOURI, USA

### Aims:

To quantitatively evaluate alternative scoring of the hand diagram in the detection of carpal tunnel syndrome. Recommended scoring of hand diagrams by Katz et al. (1990) and several modified scoring methods have produced high inter-rater reliability, but the impact of symptoms outside of the median nerve distribution has led to discordant scoring by raters (Dale et al., 2008; Franzblau et al., 1994).

### Methods:

Active workers (n=1107) participating in a longitudinal study investigating carpal tunnel syndrome in the United States completed repeated questionnaires and received electrodiagnostic testing and a physical examination (Tinel's test over carpal tunnel, Phalen's test). Subjects (n=141) with reported hand pain or paraesthesia (numbness/burning/tingling) shaded the location of symptoms on bilateral hand diagrams. Right hand diagrams were independently scored using three methods: 1) Katz scoring (classic, probable, possible, unlikely) 2) simplified rating (0-2) based upon the number of digits with palmar/distal shading (maximum of two: thumb, index, middle), and 3) middle finger palmar/distal shading (0-1). ANOVA, chi-square analyses and positive/negative predictive value (PPV/NPV) evaluated the association of scores by each rating method to the presence of abnormal median nerve conduction [distal sensory latency (DSL), distal motor latency (DML), and median-ular sensory difference (MUD)] and to the presence of findings on clinical examination (Tinel's, Phalen's).

### Results:

Of 141 subjects that completed hand diagrams, 73 (52%) showed symptoms in the median nerve distribution. Each of the three scoring methods was significantly associated with the presence of abnormal electrodiagnostics. All ratings provided similar substantial negative predictive value when evaluated against electrodiagnostic testing (ranges: DSL .78-.79, DML .88-.91, MUD .78-.79). "Classic" Katz scores produced the highest positive predictive value for abnormal electrodiagnostics (DSL .72, DML .50, MUD .67) but was similar to results from the simplified rating (DSL .62, DML .41, MUD .60) and positive middle finger score (DSL .66, DML .42, MUD .62). We found no association between any scoring method and physical examination or demographic information (Tinel's, Phalen's, obesity, age, gender, or race).

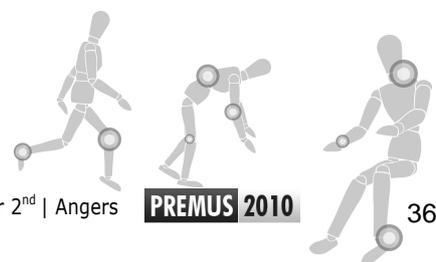
### Conclusion:

Symptoms within the median nerve distribution depicted on hand diagrams are associated with electrodiagnostic measures among active workers. The simplified rating and the middle finger score are simpler to use compared to the Katz method while maintaining similar performance characteristics.

**Keywords:** Epidemiology, Upper limb, Carpal tunnel syndrome

### References:

- Katz JN, Stirrat CR, Larson MG, Fossel AH, Eaton HM, Liang MH. A self-administered hand symptom diagram for the diagnosis and epidemiologic study of carpal tunnel syndrome. *J Rheumatol.* 1990;17:1495-1498.  
Dale AM, Strickland J, Symanzik J, Franzblau A, Evanoff B. Reliability of hand diagrams for the epidemiologic case definition of carpal tunnel syndrome. *J Occup Rehabil.* 2008;18:233-248.  
Franzblau A, Werner RA, Albers JW, Grant CL, Olinski D, Johnston E. Workplace surveillance for carpal tunnel syndrome using hand diagrams. *J Occup Rehabil.* 1994;4(4):185-198.



## LOWER LIMB DISORDERS

### STANDING, KNEELING AND SQUATTING AT WORK ASSOCIATED WITH MUSCULOSKELETAL DISORDERS: META-ANALYSES.

GOUTTEBARGE V., BOUWMAN C., FRINGS-DRESEN M.H.W., VAN DIEËN J.H., VAN DER BEEK A.J., BURDORF A.

*Coronel Institute of Occupational Health, Academic Medical Center, Amsterdam, The Netherlands*

#### Aims:

Musculoskeletal disorders (MSDs) are worldwide responsible for sick leave and work disability, being associated with working conditions such as manual material handling and awkward postures. The objective of this study was to systematically review the literature evaluating through a meta-analysis of published studies the associations between standing, kneeling and squatting at work, and low back pain (LBP), knee osteoarthritis (OA) and lower limb symptoms (LLS).

#### Methods:

Two electronic databases were systematically searched from 1999 to September 2009. In- and exclusion criteria were assessed to gather original studies written either in English or Dutch, while reference lists were checked for missing articles. Data extraction was performed in standard format and quality was assessed through five criteria scored as +, - or? (overall quality score from 0 to 5+). To be included in the meta-analyses, studies had to be of sufficient quality ( $\geq 3+$ ), have a sufficiently similar exposure and outcome definitions, and describe adjusted associations (odds ratio [OR] and 95% confidence intervals [95%CI]) between exposure to either standing, kneeling or squatting, and LBP, knee OA and/or LLS. Pooled ORs were calculated using a random effect model.

#### Results:

From 2114 references obtained through our systematic search, 26 original studies and six reviews were included. The reference check delivered nine additional studies. Finally, 25 of the 35 included original studies were of sufficient quality ( $\geq 3+$ ), being then eligible for the meta-analyses. The pooled ORs for standing were 1.23 (95%CI 0.95-1.60) and 1.31 (95%CI 1.14-1.51) for LBP, based on three cohort and five cross-sectional studies respectively, and 1.77 (95%CI 1.40-2.23) for LLS based on four cross-sectional studies. The pooled ORs for kneeling were 1.95 (95%CI 1.04-3.65) and 0.89 (95%CI 0.66-1.20) for knee OA, based on two cross-sectional and three case-control studies, respectively. The pooled ORs for squatting were 1.33 (95%CI 0.94-1.89) for LBP based on two cohort studies, and 2.24 (95%CI 0.95-5.30) and 1.16 (95%CI 0.95-1.41) for knee OA, based on two cross-sectional and three case-control studies, respectively.

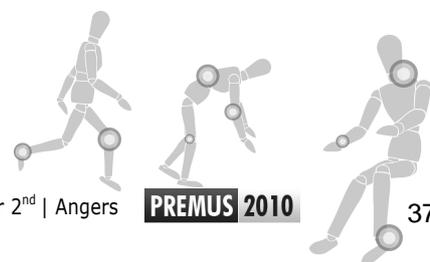
#### Conclusion:

Associations between standing, kneeling and squatting at work and MSD were primarily investigated in cross-sectional studies and, thus, difficult to interpret for causality. Cohort studies present some evidence for increasing risks for standing and squatting with LBP, albeit not statistically significant in the meta-analyses.

**Keywords:** Postures, physical exposure, Personal risk factors for MSD, Epidemiology

#### References:

Von Elm E, Altman D, Egger M, Pocock S, Gøtzsche P, Vandenbroucke J. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol.* 2008;61:344-9.  
Review Manager (RevMan), Version 5.0. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2008.



## CORRELATION BETWEEN DIFFERENT PHYSICAL EXPOSURES AND PATTERNS OF CARTILAGE DAMAGE IN THE KNEE

RIEGER M.A., QUIROS PEREA E., GEBHARDT H., LIEBERS F., KLUSSMANN A.

*Institute of Occupational and Social Medicine, Tübingen, Germany*

### Aims:

Knee osteoarthritis (OA) is characterised by destruction of the articular cartilage. Many factors have been described in literature as being in relation to the development and progress of knee OA. It is questionable whether physical exposures may cause specific apparent damages in the cartilage. If patterns of damage are differed e.g. between individuals with and without kneeling/squatting activities, this could be a reference for the amount of the work relatedness of knee OA.

### Methods:

A case control study among 729 cases (patients with knee OA) and 571 controls (patients without knee OA) was performed recently [Klussmann et al., 2010]. Within this ArGon study (ArGon = "Arbeit" (work) and "Gonarthrose" (knee OA)), the physical exposures obesity, kneeling/squatting, malalignment of the knee and sports were described as predictors for knee OA in both genders.

From the 729 cases mentioned above, 518 cases were included in further analysis. Within this subgroup, the condition of the knee cartilage was documented. All surfaces of the knee joint were divided in 48 quadrants according to the "International Cartilage Repair Society" - ICRS standard. Apparent patterns of cartilage damage in patients with different exposures were compared graphically and statistically with regard to the prevalence of damage in the respective quadrant.

### Results:

Among all cases, the most frequent damage was in the centre of the medial femur condyle (up to 63%) and - less frequent - in the medial surface of the tibia plateau (up to 48%). In subgroup analysis, the prevalence of damaged cartilage on the medial femur condyle and the medial surface of the tibia plateau even increased significantly in the group with genu varum ("bow leg") compared to those with no malalignment of the knee. The prevalence of damaged cartilage on the lateral femur condyle and the lateral surface of the tibia plateau increased significantly in the group with genu valgum ("knock knee") compared to those with no malalignment of the knee. In further comparisons (sports vs. no sports, obesity vs. normal weight, kneeling/squatting vs. no kneeling/squatting) no significant differences between the prevalence of damage in the individual quadrants could be determined.

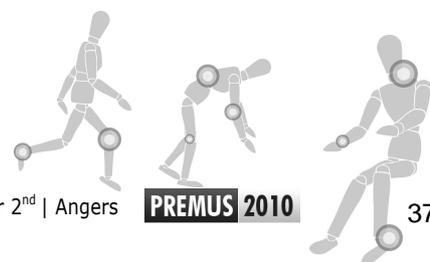
### Conclusion:

Within these examinations, specific apparent damages in cartilage could be shown only for malalignment of the knee. For the remaining physical predictors for knee OA such as kneeling/squatting, obesity and sport, no specific apparent damages could be determined.

**Keywords:** Biomechanics, Postures, physical exposure, Lower limb

### Reference:

Klößmann A, Gebhardt H, Nübling M, von Engelhardt LV, Quirós Perea E, Liebers F, Bouillon B, Rieger, MA (2010): Fall-Kontroll-Studie zur Bewertung von beruflichen Faktoren im Zusammenhang mit Gonarthrosen - die ArGon-Studie. Schriftenreihe der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Forschung Fb 2096, Dortmund/Berlin/Dresden, BAuA Eigenverlag, Dortmund



## VALIDITY OF SELF-ASSESSED REPORTS AND MEASURING DATA ON WORK-RELATED KNEE STRAINING ACTIVITIES – RESULTS OF A CROSS SECTIONAL STUDY

DITCHEN D.M., ELLEGAST R.P., HARTMANN B., RIEGER M.A.

IFA - Institute for Occupational Safety and Health of the German Social Accident Insurance, Sankt Augustin, Germany; Arbeitsmedizinischer Dienst der BG BAU, Hamburg, Germany; Department of Occupational Health and Environmental Medicine, Institute of Ge

### Aims:

Work-related knee straining activities like kneeling or squatting are regarded as risk factors for diseases of the knee, e.g. osteoarthritis. Usually, in corresponding epidemiological studies exposure assessment is conducted retrospectively by interview or questionnaire, e.g. [1]. In order to verify the validity of self-reported exposure data, a cross sectional study was launched to analyse knee straining postures both by measurements and questionnaires.

### Methods:

190 male subjects (mean age 35.0, SD=11.5) working in 20 different professions participated in the study. Posture capturing was performed in field with the measuring system CUELA [2]. The mean duration of one measurement was about two hours (mean 118 min, SD=44 min). Immediately after the measurement, all study participants were asked to fill out a questionnaire to estimate the duration of time they worked in five knee straining postures. Musculoskeletal disorders were assessed by Nordic Questionnaire. Statistical analysis was performed by using Wilcoxon rank-sum test, Spearman's rank correlation and Bland-Altman-plots [3].

### Results:

The results of the self-reports differ highly from those of the measurements (mean relative difference 444,8%, SD=1121,1%), showing no significant difference between the single postures or the sum of all postures. The differences augment with increasing exposure. Though overestimation of the exposure is observed more often, underestimation occurs as-well (Figure 1). Thus, the relation between the results of both methods cannot simply be described by a mathematical equation. Concerning the validity of self-reports between subjects with or without knee disorders, no significant difference can be detected.

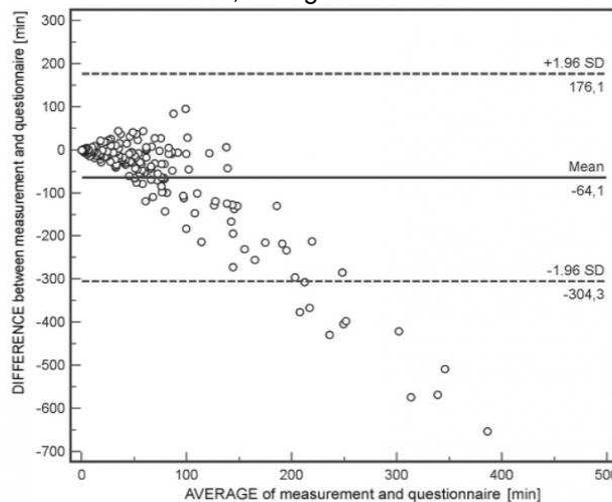


Figure 1: Comparison between measurement and questionnaire for knee straining postures in total (Bland-Altman-plot; n=183 (190 minus 7 extreme values))

### Conclusion:

The study results show the need for using accurate exposure data in epidemiological studies because self-assessed retrospective exposure can highly differ from real conditions. Therefore it is useful to collect and process valid measurement data to build up exposure databases.

**Keywords:** Postures, physical exposure, Exposure measurement methods, Lower limb

### References:

- [1] Sandmark H, Hogstedt C, Vingard E. Primary osteoarthritis of the knee in men and women as a result of lifelong physical load from work. *Scand J Work Environ Health*. 2000;26(1):20-25.
- [2] Ellegast, RP, Hermanns I, Schiefer C. Workload Assessment in Field Using the Ambulatory CUELA System. In: Duffy, V.G. (Ed.) *Digital Human Modeling HCII*. 2009, Springer, Berlin 2009: 221-226.
- [3] Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*.1986(i):307-10.



**WORK PARTICIPATION, WORK ADAPTATIONS, SICK LEAVE AND SELF-REPORTED HEALTH STATUS IN EARLY OSTEOARTHRITIS. A 2-YEAR FOLLOW-UP STUDY IN THE COHORT HIP AND COHORT KNEE (CHECK-STUDY).**

BIELEMAN H.J.<sup>1</sup>, RENEMAN M.F.<sup>3</sup>, DROSSAERS-BAKKER K.W.<sup>2</sup>, GROOTHOFF J.W.<sup>3</sup>, OOSTERVELD F.G.J.<sup>1</sup>

<sup>1</sup> Saxion Universities of Applied Sciences - <sup>2</sup> Rheumatology Twente – <sup>3</sup> University Medical Centre Groningen.

**Aims:**

To document the longitudinal course of work participation of people with early osteoarthritis (OA) in hips or knees from baseline (T0) to 2-year follow-up (T2) in the Cohort Hip and Cohort Knee (CHECK-study) and to compare health status and personal factors of subjects who continued working and those who stopped. To compare prevalence of work adaptations at T2 and T0. To compare (cross-sectional at T2) health status and personal factors of workers reporting sick-leave ( $\geq 1$  week) and those reporting no sick-leave (or  $<1$  week).

**Methods:**

Questionnaire data from 925 subjects were analyzed. Rate ratios were calculated to compare work participation with the general Dutch population, corrected for age, sex and education. Self-reported health status (SF-36, WOMAC) was compared between groups (continued working versus stopped; sick-leave versus no sick-leave at T2) using t-tests.

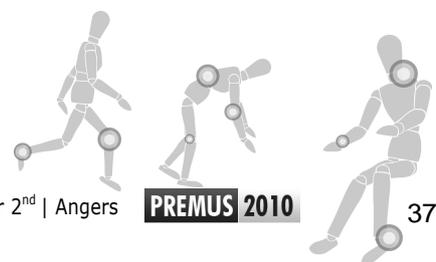
**Results:**

Participation in the cohort (mean age 58, 79% females) decreased from 51% to 46%, similar to the general population. Subjects who stopped working were older than those who continued working (mean 4.4 years), but did not differ in any other factor. Twenty percent reported work adaptations, compared to 14% at baseline. Subjects reporting sick-leave the past year because of hip/knee complaints (11%, similar to baseline) had significantly worse health and higher medical consumption than those without sick-leave.

**Conclusion:**

The course of work participation of people with early OA is similar to the general population. However, frequent work adaptations and the inferior health of subjects reporting sick-leave indicate an impact of OA on work participation.

**Keywords:** Epidemiology, Social aspects of MSD, Lower limb



## PREDICTORS FOR KNEE OSTEOARTHRITIS - RESULTS OF THE CASE CONTROL STUDY "ARGON"

KLUSSMANN A., GEBHARDT H., LIEBERS F., VON ENGELHARDT L.V., QUIROS E., DAVID A., BOUILLON B., RIEGER M.A.

*Institute of Occupational Health, Safety and Ergonomics (ASER), Wuppertal, Germany*

### Aims:

A number of occupational factors and other factors are discussed in relation to the development and progress of knee osteoarthritis (OA). The distinction between work-related factors and other factors is crucial in assessing the risk and in deriving preventive measures in occupational health. The aim of the research project "ArGon" (an acronym for "Arbeitsbedingungen" [working conditions] and "Gonarthrose" [knee OA]) was to determine the importance of different occupational factors (e.g. kneeling and squatting activities, the lifting and carrying of loads, standing, jumping) in relation to other factors of influence (e.g. age, gender, constitutional factors, sports) for the occurrence of knee OA in Germany.

### Methods:

In a case-control study patients with and without knee OA were questioned by means of a standardised questionnaire complemented by a semi-standardised interview. Controls were matched assigned to the cases. Conditional logistic regression was used in analysing data.

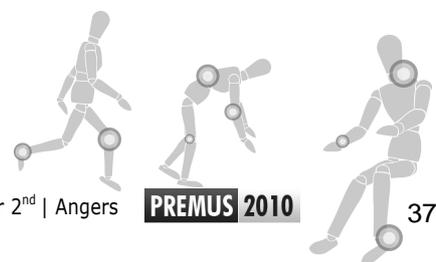
### Results:

739 cases and 571 controls were included in the study. In women and men several individual and occupational predictors for knee OA could be described: obesity (Odds Ratio (OR) up to 17.65 in women [w] and up to 12.56 in men [m]); kneeling/squatting (w: OR 2.52 [ $> 8,934$  hours/life], m: 2.16 [574-12,244 hours/life], 2.47 [ $> 12,244$  hours/life]); genetic predisposition (OR 2.17 [w], 2.37 [m]); and sports with a risk of unapparent trauma (w: OR 2.47 [ $\geq 1,440$  hours/life], m: 2.58 [ $\geq 3,232$  hours/life]). In women, malalignment of the knee (OR 11.54), pain in the knee already in childhood (OR 2.08), and daily lifting and carrying of loads ( $\geq 1,088$  tons/life, OR 2.13) were related to an increased, sitting and smoking led to a reduced OR.

### Conclusion:

A dose response relationship for kneeling/squatting and knee OA for both men and women could be proved. The results concerning general and occupational predictors for knee OA reflect the findings from the literature quite well. Yet occupational risks such as jumping or climbing stairs/ladders, discussed in the literature, did not correlate with knee OA in the present study. With regards to occupational health, prevention measures should focus on the reduction of kneeling activities and the lifting and carrying of loads as well as general risk factors, most notably the reduction of obesity. More intervention studies of the effectiveness of tools and working methods for reducing knee straining activities are needed.

**Keywords:** Postures, physical exposure, Early prevention, Lower limb



## OCCUPATIONAL PHYSICAL ACTIVITY AND MENISCAL TEARS: A REVIEW OF THE EPIDEMIOLOGICAL LITERATURE

RYTTER S.<sup>1</sup>, KIRKESKOV L.<sup>2</sup>

<sup>1</sup> Department of Orthopaedic Surgery, Hospital Unit West Herning, Denmark – <sup>2</sup> Department of Occupational and Environmental Medicine, Bispebjerg Hospital, Denmark.

### Aims:

To conduct a systematic review of the literature examining the association between occupational physical demands and meniscal tears.

### Methods:

A comprehensive literature search involving electronic databases (Medline, Embase, Cinahl, SweMed, Web of Science, and Cochrane) were searched along with the reference list of relevant publications. Peer reviewed publications published in English and concerning the incidence or prevalence of knee disorders in different occupational trade groups comprised the search criteria.

### Results:

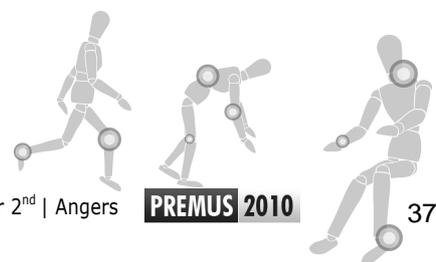
The literature search revealed only few relevant articles concerning the topic. Merging results from the databases a total number of 12 non-duplicate articles were found. The majority focused on occupational knee demands among workers in the construction and mining industry. Studies revealed a significantly increased prevalence of meniscal tears among workers with kneeling and squatting work tasks especially in floor layers and miners.

### Conclusion:

The menisci are two wedge-shaped discs of fibrocartilaginous tissue located in each tibiofemoral compartment. They are an important multifunctional component of the knee joint, and play an essential role in load transmission, shock absorption, proprioception, joint stability, and lubrication. During ambulation there is a load imbalance between medial and lateral tibiofemoral contact forces, and diversity in meniscal movements between the anterior and posterior part of the menisci. These biomechanical changes are especially marked during deep knee flexion, and may in combination with repetitive high knee loads and associated microtrauma when getting from kneeling to the upright position exceed the threshold for meniscal tearing, and explain an association between occupation-related kneeling and meniscal tears.

In conclusion epidemiological studies suggest that frequent occupational kneeling and squatting, and not only pivoting knee traumas may be an example of an environmental risk factor in the development of meniscal tears.

**Keywords:** Mechanism of pain and tissue injury, Construction, Lower limb



**PREVENTION: EDUCATION, TRAINING, LIFESTYLE****PHYSICAL ACTIVITY, DIET AND COGNITIVE BEHAVIORAL TRAINING AS A COMBINED WORKSITE-BASED LIFESTYLE INTERVENTION TO REDUCE WEIGHT AND MUSCULOSKELETAL DISORDERS IN HEALTH CARE WORKERS**CHRISTENSEN J.R.<sup>1</sup>, OVERGAARD K.<sup>2</sup>, HOLTERMANN A.<sup>3</sup>, SØGAARD K.<sup>4</sup><sup>1</sup> Department of Sport Science, Aarhus University, Aarhus, Denmark - <sup>2</sup> Department of Sport Science, Aarhus University, Aarhus, Denmark - <sup>3</sup> National Research Centre for the Working Environment, Copenhagen, Denmark - <sup>4</sup> Institute of Sport Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark**Aims:**

Health care workers in Denmark have a high prevalence of overweight, low physical capacity, musculoskeletal disorders (MSD) and low workability. The aim of this study was to reduce body weight and MSD through a work-site based lifestyle intervention among health care workers.

**Methods:**

The study was performed as a single-blinded randomized controlled trial (RCT). 140 health care workers were randomized into intervention or reference group. The 3 months intervention consisted of weekly 60 min sessions during working hours. Participants with BMI>24.9 were encouraged to follow an individual dietary plan with an energy deficit of 1200 kcal/day and body weight was monitored weekly. Cognitive behavioural training was given with focus on diet change, brief physical exercises (aerobic and strengthening) were performed and additionally, leisure time exercise was planned for 2 hours weekly. The reference group were offered monthly 2 hours group-seminars on health related topics. Body weight, blood pressure and self-reported MSD were registered before and after intervention and analyzed with a paired t-test (significance level P

**Results:**

Among the 140 health care workers with a mean age of 45.6 years 89, 64.5% had a BMI above 24.9. As shown in table 1, we found a significant decrease in body weight, BMI and blood pressure in the intervention group while the reference group was unchanged. No significant effect was found on MSD in either group.

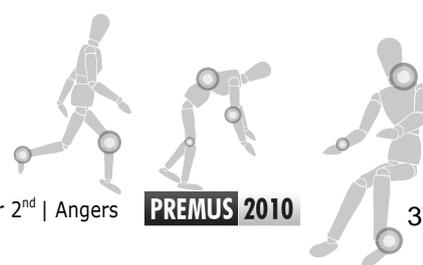
Table 1. Body-weight, BMI, blood-pressure and musculoskeletal pain last 7 days. P-values represent before- and after tests within groups.

	Intervention (n= 69)		P-value	Reference (n= 71)		P-value
	Baseline	3 month		Baseline	3 month	
Body-weight (kg)	79,2 ± 17,2	76,3 ± 16,9	<0,001	75,1 ± 16,7	75,6 ± 16,8	0,067
BMI	28,7 ± 6,0	27,6 ± 5,9	<0,001	27,4 ± 5,7	27,6 ± 5,9	0,179
Systolic pressure (mmHg)	132,6 ± 19,4	125,1 ± 18,6	<0,001	127,1 ± 13,3	125,7 ± 13,1	0,174
Diastolic Pressure (mmHg)	84,2 ± 11,8	78,5 ± 10,2	<0,001	80,6 ± 9,1	79,7 ± 8,9	0,275
Neck (%)	30,9	23,4	NS	33,8	33,9	NS
Shoulder (%)	47,8	34,4	NS	29,2	30,8	NS
Upper back (%)	22,4	17,2	NS	15,4	10,2	NS
Lower back (%)	38,8	32,8	NS	33,8	26,1	NS

**Conclusion:**

The 3 month intervention significantly reduced weight, BMI and blood-pressure. The study provides evidence, that worksite-based lifestyle interventions may improve cardiovascular health in health care workers, known to have a high prevalence of lifestyle related problems. A 9 months follow up may reveal if the weight loss can be maintained and in a long term perspective affect MSD and work ability among health care workers.

**Keywords:** Health care workers, Intervention studies, Specific health outcomes



## EFFECTS OF HEALTH CHECK BASED WORK SITE PHYSICAL EXERCISE INTERVENTION AMONG EMPLOYEES WITH PHYSICALLY HEAVY WORK. A RANDOMIZED CONTROLLED STUDY.

GRAM B.<sup>1</sup>, BACHMANN R.H.<sup>1</sup>, HOLTERMANN A.<sup>2</sup>, SØGAARD K.<sup>1</sup>, SJØGAARD G.<sup>1</sup>

<sup>1</sup> Institute of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark - <sup>2</sup> National Research Centre for the Working Environment, Copenhagen, Denmark.

### Aims:

This study introduces a new intervention concept to improve general health as well as musculoskeletal health by implementing an individual, health check based exercise intervention. The aim of this study is to assess at a health check the physical and metabolic fitness, general health, and musculoskeletal disorders in workers with heavy work load, and to evaluate the effect of individually tailored exercise programs on aerobic capacity, muscle strength, musculoskeletal health, general health, work ability, and sickness absenteeism.

### Methods:

The study design is a randomized controlled intervention study with two study groups: Exercise (strength and aerobic training) and Control. The intervention period lasts 12 weeks and the participants train 3 x 20 minutes a week. The participants are construction workers, who complete health checks before and after intervention including measures of anthropometry, Blood pressure, VO<sub>2</sub> max, muscle strength, fat%, pain, and blood lipids. Data from the first health check were used for the design of specific type of intervention exercise.

### Results:

The present data include 31 male construction workers, baseline data shown in Table 1. The changes with intervention were significantly different between groups regarding VO<sub>2</sub>max:  $\Delta$  0.57 L/min for the Exercise and  $\Delta$  0.10 L/min for the Control group,  $p=0.01$ . Body weight was unchanged and thus VO<sub>2</sub>max/kg body weight increased more in the exercise group, mean (SD): from 24.9 (6.5) to 30.2 (7.7) ml/min/kg than in the control group: from 23.6 (4.9) to 24.0 (4.9) ml/min/kg,  $p = 0.02$ . No significant changes occurred in muscle strength (abdomen/back).

Table 1. Baseline Demographic, musculoskeletal health and Clinical Characteristics of Trial Group and Control Group

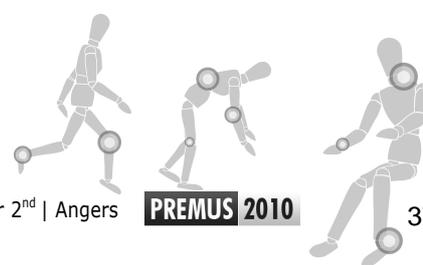
Characteristic	Exercise Group N=17	Control Group N=14	
Male, n=31			
Age, years	46±10.3	46±10.7	NS
Weight, kg	92±18.1	97±23.4	NS
Bmi	29±4.5	29±5.9	NS
VO <sub>2</sub> max, L/min	2.81±0.6	2.86±0.6	NS
Muscle strength/abd, Kg	72.6±13.5	78.2±16.7	NS
Muscle strength/back, Kg	74.1±16.3	75.8±24.0	NS
HDL-Chol mm/L	1.4±0.3	1.3±0.2	NS
LDL-Chol mm/L	3.3±0.5	3.3±1.9	NS
BP syst. mmHg	133±13.8	135±8.4	NS
BP diast. mmHg	85±8.4	87±12.8	NS
Fat, %	25.3±5.1	25.6±6.7	NS
Pain >30 days previous year (%)			
- Neck	23.5	50.0	NS
- Low back	47.1	57.3	NS
- Knees	35.3	35.7	NS

Values are Mean (SD) and number (%).

### Conclusion:

The group of construction workers had at baseline a low VO<sub>2</sub>max. Ten min aerobic training at 70% of VO<sub>2</sub>max 3 times weekly significantly increased VO<sub>2</sub>max with a clinically relevant amount regarding risk for metabolic and cardiovascular disorders.

**Keywords:** Construction, Intervention studies, Specific health outcomes



## EFFECT OF SPECIFIC STRENGTH TRAINING ON NECK/SHOULDER PAIN: A RANDOMIZED CONTROLLED TRIAL AMONG INDUSTRIAL WORKERS

ZEBIS M.K., ANDERSEN L.L., PEDERSEN M.T., MORTENSEN P., ANDERSEN C.H., PEDERSEN M.M., BOYSEN M., ROESSLER K.K., HANNERZ H., SJØGAARD G.

National Research Centre for the Working Environment, Copenhagen, Denmark

### Aims:

A high number of laboratory technicians complain about musculoskeletal pain, primarily in the neck and the upper extremities. The aim of the present study was to investigate the effect of a specified worksite strength training intervention on non-specific neck-shoulder pain among industrial workers.

### Methods:

A cluster randomized controlled trial of 20 weeks was performed in Copenhagen, Denmark, between January and June 2009. In total 533 participants were randomized at the cluster level to either intervention (n=277) or control group (n=256). The intervention group performed supervised high-intensity specific strength training 3 x 20 min a week with 4 different dumbbell exercises locally for the neck and shoulder muscles and 1 exercise for the forearm. Intensity of pain in the neck and shoulder were rated on a scale from 0-9 before and after the intervention. Further, self-reported training compliance was reported in the questionnaire after the intervention.

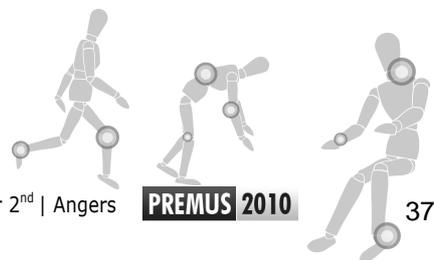
### Results:

There was no significant difference in pain intensity between groups at baseline. Pain intensity in the neck and shoulder decreased  $53\pm 28\%$  and  $42\pm 20\%$ , respectively, in the intervention group, and  $15\pm 7\%$  and  $12\pm 1\%$ , respectively, in the control group. This was significantly greater in the intervention group compared with the control group ( $P < 0.0001$ ). Training compliance was high, 85% of the participants had performed the exercises at least once a week.

### Conclusion:

Specific strength training effectively reduced neck and shoulder pain among industrial workers with a high prevalence of musculoskeletal pain. Thus, specific strength training has a high clinical relevance in the rehabilitation of non-specific neck/shoulder pain.

**Keywords:** Intervention studies, Neck, Pain, Chronic pain



## EVALUATION OF A CANADIAN MASS MEDIA CAMPAIGN AIMED AT PREVENTING DISABILITY FROM BACK PAIN

GROSS D.P., RUSSELL A.S., FERRARI R., BATTIE M.C., SCHOPFLOCHER D., HU R., WADDELL G., BUCHBINDER R.

*Faculty of Rehabilitation Medicine, University of Alberta, Canada*

### Aims:

Building on previous back pain mass media campaigns aimed at preventing disability due to back pain (slogan: Don't Take it Lying Down), a related media campaign was implemented in Alberta, Canada. A variety of media formats were used with radio ads predominating due to budget constraints. We evaluated the Alberta media campaign's impact on population back pain beliefs, work disability and health utilization outcomes.

### Methods:

Quasi-experimental before-and-after design with a non-exposed control group. Changes in back pain beliefs were studied using telephone surveys of random samples from both provinces before campaign onset and afterwards. The Back Beliefs Questionnaire (BBQ) was used along with specific questions about the importance of staying active. For evaluating behaviours, we extracted data from governmental and workers' compensation databases from 1999 to 2008. Outcomes included indicators of number of visits to health care providers, use of diagnostic imaging, and compensation claim incidence and duration. Analysis included time series analysis and ANOVA testing of the interaction between province and time.

### Results:

Belief surveys were conducted with a total of 8566 subjects over the four-year period. In terms of exposure to campaign messaging, the proportion of subjects reporting exposure increased consistently in the intervention province after the campaign started (to a high of 49.2% in 2008) whereas reported awareness was not as great in the control province (high of 38.8% in 2008). Changes on BBQ scores were not statistically significant, however the proportion of subjects agreeing with the statement, "If you have back pain you should try to stay active" increased in the intervention province from 56% to 63% ( $p = 0.008$ ) with no change in the control group (consistently ~60%). This improvement remained statistically significant after controlling for age, sex, urban residence, previous back pain experience, and awareness of media messaging. No meaningful or statistically significant effects of the campaign were seen on any of the workers' compensation claim outcomes (including no effect on first time back claims) or health utilization data.

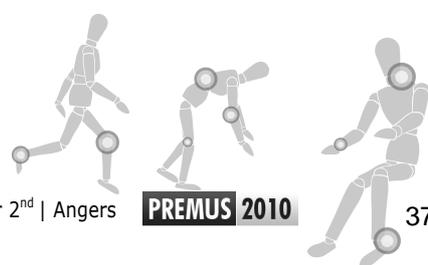
### Conclusion:

A Canadian media campaign appears to have had a small impact on public beliefs specifically related to campaign messaging to stay active, but no impact was observed on work disability or health utilization outcomes. Results are likely due to the modest level of awareness achieved by the campaign and future campaigns will likely require more extensive media coverage.

**Keywords:** Psychosocial factors, Intervention studies, Back, low back

### References:

- Buchbinder R, Jolley D, Wyatt M. Population based intervention to change back pain beliefs and disability: three part evaluation. *Bmj*. 2001 Jun 23;322(7301):1516-20.
- Waddell G, O'Connor M, Boorman S, Torsney B. Working Backs Scotland: a public and professional health education campaign for back pain. *Spine*. 2007 Sep 1;32(19):2139-43.



## DYNAMIC TRAINING ON THE LUMBAR MUSCULATURE TO PREVENT RECURRENCE OF ACUTE LOW BACK PAIN: A RANDOMIZED CONTROL TRIAL USING A DAILY PAIN RECALL FOR ONE YEAR

CIRIELLO V.M., SHAW W.S., RIVARD A.J., WOISZWILLO M.

*Liberty Mutual Research Institute for Safety, Hopkinton, MASSACHUSETTS, USA*

### Aims:

The aim of this study was to quantify lumbar muscle endurance training for individuals with a recent episode of acute low back pain (> moderate pain for > 2 days) and to observe whether the training would reduce the rate and severity of recurrent low back pain episodes.

### Methods:

Twenty-six acute low back candidates who were pain free at the time of the study were randomly divided into a experimentally trained group and a sham trained control group. The experimental group trained by performing preloaded maximum isokinetic exertions of the back extensors consisting of 5 sets of 10 repetitions, 3 days a week for 4 weeks (12 sessions). The sham control group trained the same 12 days but with a program which had minimal effect on the back musculature. After training, the two groups were followed for one year and each patient was required to report daily pain logs on a weekly basis on a interactive voice response phone system.

### Results:

The results revealed that, contrary to the hypothesis, the experimentally trained group experienced significantly ( $p=.03$ ) more pain days in the minor and moderate category and more episodes of acute low back pain than the sham controlled group. However, there was a strong trend that indicated that the experimentally trained group experienced less pain in the severe, intense, and excruciating categories. The sham control group also reported significantly ( $p=.03$ ) more pain free days than the trained group.

### Conclusion:

We propose that the endurance training in this experiment sensitized the musculature of the experimentally trained group for greater reporting of LBP in the lower categories of pain. Whereas, the sham trained control subjects were able to contend with lower levels of pain. We also suggest that the sham trained subjects were convinced that the training was beneficial for their backs. The placebo effect can be substantial in pain reporting and should not be dismissed as a true effect in this experiment. The sham training, although essentially a isometric postural maneuver, may have instilled a sense of consciousness about core tightness and control which in turn translated into postural behaviors which alleviated the reporting of minor and moderate pain levels. Future experimentation with greater numbers is necessary to assert whether this was a placebo or a true training effect. This study points to the need for a larger RCT with daily recalls for 365 days to confirm the results of this limited study.

**Keywords:** Muscle activity, Intervention studies, Back, low back.



## A MULTIDISCIPLINARY PREVENTION OF WORK-RELATED MUSCULO-SKELETAL DISORDERS OF GRAVEDIGGERS: CONFRONTATION WITH BIOMECHANICAL ANALYSES USING THE METHODOLOGY OF THE CLINIC OF ACTIVITY THEORY.

SIMONET P.<sup>1</sup>, FERNANDEZ G.<sup>1</sup>, CLOT Y.<sup>1</sup>, VAN TRIER M.<sup>2</sup>, SAVESCU A.<sup>3</sup>, GAUDEZ C.<sup>3</sup>, AUBLET-CUVELIER A.<sup>3</sup>

<sup>1</sup> CRTD (EA 4132), Clinic of activity, CNAM Paris, France - <sup>2</sup> SMPP, City of Paris, France - <sup>3</sup> Biomechanics and Ergonomics Laboratory, French National Institute of Health and Safety at Work, Vandoeuvre-lès-Nancy, France

### Aims:

The occupational health physician noticed complaints about shoulder and low back disorders in gravediggers. A complicated trade gesture emerged from a preliminary analysis of their activity: the throwing backward gesture. To examine its complexity we realized a multidisciplinary framework with the clinic of activity approach and the biomechanical analyses. Such frame made it possible to develop the means for a co-analysis with the gravediggers concerning the conditions of its execution. This paper proposes to emphasize:

- the different methodological steps of this multidisciplinary framework;
- the psychological function of the collective working controversies that is based on the fact that “knowledge is always an effort to solve contradictions” (Wallon, 1942/1970).

### Methods:

The methodology of the “clinic of activity” theory distinguishes two stages (Clot, Fernandez & Carles, 2002): the simple self-confrontation and the crossed self-confrontation. These stages were realized, in that frame, with the biomechanical analysis. The gravediggers were confronted with videos that showed several throwing backward gestures that were delaminated by the analysis of the researchers: they fixed - with their own criteria - the beginning and the end of each of the gestures studied.

### Results:

1- The simple self-confrontation aimed to develop dialogues into each of the gravediggers involved into the frame. In that way, each gravedigger was confronted with the video of two series corresponding to the throwing backward gesture requiring the most and the least muscle activity level, and the related quantitative evaluation. Then, researchers encouraged him to compare his own movement with his colleagues' movement. As result each of them realized questions concerning his professional attitude.

2- The crossed self-confrontations with two gravediggers aimed to develop their occupational controversies. The researchers pinpointed the gravediggers' interpersonal differences with the willingness to arouse - into each of them - the other unrealized possibilities (Vygotsky, 1934/1997). As result, the gravediggers rehearsed different ways to reinvent their own throwing backward gestures and more globally their own professional movement.

### Conclusion:

Such frame made it possible for the gravedigger to:

- Rediscover some of the dilemmas linked to the realization of his own movement, like: how to use different parts of his body (hands on sleeve of the tool, thighs, and feet on the ground...) or, how to give an efficiency impetus to his body in order to throw out the earth from the grave?
- Arouse collective dialogues into his activity of thinking by transforming the gesture evaluated as a controversy object.

**Keywords:** Biomechanics, Intervention methods, Upper limb.

### References

Clot, Y., Fernandez, G., & Carles, L. (2002). Crossed self-confrontation in the clinic of activity. 11th Eur. Conf. On Cognitive ergonomics. Catalina, Italia, pp. 13-18.

Vygotski, L. (1934/1997). Pensée et langage (F. Sève, trad.). Troisième édition. La Dispute, Paris.

Wallon H. (1942/1970). De l'acte à la pensée. Flammarion, Paris.



## PREVENTION IN VARIOUS SECTORS

### SUBGROUP ANALYSIS OF A RANDOMIZED COMPARATIVE TRIAL ON ERGONOMICS IN KITCHEN WORK

TAKALA E.P., PEHKONEN I.

*Finnish Institute of Occupational Health, Helsinki, Finland*

#### **Aims:**

Efficacy of participative ergonomic interventions aimed to reduce workload and musculoskeletal disorders (MSDs) were studied in municipal kitchens (1). The intention-to-treat analysis of the randomized trial did not show efficacy of the intervention (2). It was - however - known that the magnitude of interventions varied in the intervention group and similar interventions occurred also in some kitchens of the comparison group. The aim of this study was to explore whether the perceived workload of tasks reduced more in the kitchens with remarkable changes in comparison to those with no or minor changes.

#### **Methods:**

The researchers recorded descriptions of all interventions during the project. The potential impact of these interventions to reduce the load on different body parts during the work tasks was rated on a scale from 10 to +10. Proportional duration of tasks in the kitchen was used as weight factors while the ratings were summed up to describe the impact of all interventions.

The workers estimated the perceived workload of predefined tasks with a seven step scale every three months. The mean rating of workers was calculated to present the perceived workload of each task in each kitchen. In the intervention kitchens the workers also rated after the intervention how much the ergonomic changes had reduced physical workload.

In the analysis perceived workload in the kitchens with the highest impact (highest quartile) were compared to those with no or only minimal impact.

#### **Results:**

Some intervention occurred in 96 of the 119 kitchens. Generally, the time weighted sum impact was low for most kitchens. The maximum impact rating used was 5, mostly for tasks where the peak load of material handling was reduced. For tasks with the lowest perceived workload at baseline (preparing food) the mean perceived workload slightly decreased after interventions in the group with highest estimated impact whereas the workload increased in the kitchens without improvements. For other tasks no association was detected between the intervention and perceived workload.

#### **Conclusion:**

The estimated time-weighted sum impact of the interventions was low with respect to the total load of kitchen work. This may explain the negative results in the randomized trial. Still the perceived workload had decreased in some tasks in kitchens with great amount of ergonomic interventions while no change was seen in the kitchens with no or minimal interventions. Further analysis will show if the reduction of MSDs was associated with a higher estimated impact.

**Keywords:** Postures, physical exposure, Exposure measurement methods, Intervention studies.

#### **References:**

- Pehkonen I, Takala E-P, Ketola R, Viikari-Juntura E, Leino-Arjas P, Hopsu L, et al. Evaluation of a participatory ergonomic intervention process in kitchen work. *Appl Ergonomics*. 2009;40(1):115-23.
- Haukka E, Leino-Arjas P, Viikari-Juntura E, Takala EP, Malmivaara A, Hopsu L, et al. A randomised controlled trial on whether a participatory ergonomics intervention could prevent musculoskeletal disorders. *Occup Environ Med*. 2008;65(12):849-56.



## APPLYING ERGONOMICS AND BIOMECHANICS TO REDUCE INJURIES AND INCREASE PRODUCTIVITY IN A COMMERCIAL LIGHTING MANUFACTURING FACILITY: A CASE STUDY

KAPELLUSCH J., SIEBERS S., GARG A.

Center for Ergonomics, University of Wisconsin – Milwaukee, Milwaukee, Wisconsin, USA

### Aims

The objectives of this study were to use biomechanical analyses and job design to (i) reduce musculoskeletal injuries and (ii) improve productivity in the production facility of a medium sized manufacturer of commercial light fixtures.

### Methods:

An ergonomics team consisting of senior managers, industrial engineers, physical therapist, and academic consultant was assembled to quantify physical exposure musculoskeletal disorder (MSD) risk factors associated with production jobs in the manufacturing facility. All production employees were provided with MSD symptom recognition training. Supervisors and managers were provided with ergonomics training designed to provide appreciation for the benefits of commitment to superior ergonomics. The team relied on (i) self reporting of MSD symptoms from production employees through a readily available MSD symptom recognition form, (ii) quantitative job analyses using tools such as the Revised NIOSH Lifting Equation, and Strain Index, and (iii) comprehensive review of injury records to identify jobs in need of ergonomics interventions. The team prioritized interventions based on ease of implementation, potential for preventing future injuries, and number of employees affected. Ergonomics interventions ranging from simple tooling changes to comprehensive job re-design were performed throughout the first two years of the initiative. Beginning year three, the initiative began proactively redesigning jobs (before injuries were reported) to simultaneously improve productivity and safety.

All interventions were based on engineering solutions developed from quantitative ergonomics job evaluations. Specific intervention teams commonly consisted of industrial engineers, production employees, and physical therapist.

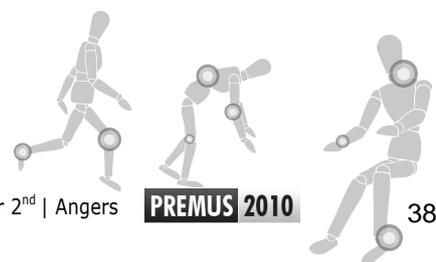
### Results:

The first year of the ergonomics initiative reduced workers' compensation costs by 85% from US\$1,833 to US\$277 per production employee. Costs were further reduced to US\$28 per employee across the next four years. Per employee compensation costs remained below US\$50 each subsequent year (total seven years to present). Lost workdays were reduced from 199 during the year prior to the initiative to zero by year seven. Since the initiative began, direct labor production hours increased 24%. During the same time, sales volume increased 114%, indicating 5% year over year growth in productivity.

### Conclusion:

Engineering based ergonomics interventions, developed using teamwork and with strong management support, have tremendous impact on reducing MSDs in workers. Using principles of biomechanics during job redesign, dramatic improvements in productivity can be made. Cost savings associated with productivity improvements can be used to justify ongoing ergonomics interventions long after worker injuries have been reduced or eliminated.

**Keywords:** Biomechanics, Early prevention, Intervention studies



## EFFECT OF WORKPLACE INTERVENTIONS ON UPPER EXTREMITY MSDS: A SYSTEMATIC REVIEW

IRVIN E.L.<sup>1</sup>, KENNEDY C.A.<sup>1</sup>, AMICK B.C.<sup>1</sup>, DENNERLEIN J.T.<sup>2</sup>, BREWER S.<sup>3</sup>, SERRA C.<sup>4</sup>, GERR F.<sup>5</sup>, FRANZBLAU A.<sup>6</sup>, VAN EERD D.<sup>1</sup>, MAHOOD Q.<sup>1</sup>, WILLIAMS R.<sup>7</sup>, EVANOFF B.<sup>8</sup>, REMPEL D.<sup>9</sup>

<sup>1</sup> Institute for Work & Health, Toronto, Canada – <sup>2</sup> Harvard University, Boston, USA – <sup>3</sup> Chemplan Inc., Sarasota, USA – <sup>4</sup> Institut Municipal de la Salut, Barcelona, Spain – <sup>5</sup> University of Iowa, Iowa City, USA – <sup>6</sup> University of Michigan, Ann Arbor, USA – <sup>7</sup> McMaster University, Canada – <sup>8</sup> Washington University at St. Louis, USA – <sup>9</sup> University of California, San Francisco, USA

### Aims:

Little is known about the most effective occupational health and safety (OHS) interventions to reduce upper extremity musculoskeletal disorders (MSDs) and injuries. This is a presentation of a systematic review that examined the peer-reviewed evidence to answer whether “OHS interventions had an effect on upper extremity musculoskeletal symptoms, signs, disorders, injuries, claims and lost time” and to identify which specific types of OHS interventions are effective.

### Methods:

A review team of 14 researchers from the United States, Canada and Europe used a “best evidence synthesis” approach to answer the research question. The multidisciplinary team had backgrounds in epidemiology, ergonomics, kinesiology, occupational medicine, physical therapy, safety engineering and information science. The review process involved six steps: (1) developing the review question; (2) creating and completing a literature search; (3) assessing relevance of the articles; (4) assessing their quality; (5) extracting data; and (6) synthesizing the evidence. The team searched five bibliographic databases along with the reference lists of included studies; in addition, the team contacted experts in the field for relevant in-press articles.

### Results:

The review process identified 36 studies of sufficient methodological quality to be used for data extraction and evidence synthesis. The findings include strong evidence that making workstation adjustments alone will have no effect on MSDS, although the evidence with regard to OHS interventions in general is mixed. In addition, there is moderate evidence that biofeedback training and job stress management training have no effect on musculoskeletal (MSK) outcomes. Moderate evidence does support the beneficial effects of arm supports. Finally, there is limited evidence that (1) ergonomics training combined with workstation adjustments, new chairs, and rest breaks has a positive effect, and (2) cognitive behavioural training and miscellaneous work redesign strategies have no effect.

### Conclusion:

Across all interventions, there is a mixed level of evidence concerning the effect of OHS interventions on upper extremity MSK outcomes. An OHS intervention approach that relies solely on adjustments to computing workstations is strongly discouraged. A moderate level of evidence suggests that biofeedback training and job stress management training have no effect on upper extremity MSK outcomes. The implementation of either of these interventions to reduce upper extremity MSK outcomes is discouraged. Based on these findings it seems reasonable to consider the usefulness of conducting further studies focused solely on workstation adjustments, biofeedback training, or job stress management.

**Keywords:** Early prevention, Intervention studies, Upper limb



## ENHANCING MUSCULOSKELETAL HEALTH AND PERFORMANCE THROUGH TRAINING COMBINED WITH A SIT-STAND WORKSTATION

ROBERTSON M.M., CIRIELLO V.M., GARABET A.

*Liberty Mutual Research Institute for Safety, Hopkinton, MASSACHUSETTS, USA*

### Aims:

Upper extremity work related musculoskeletal disorders and visual symptoms among office and intensive computer users is widespread and the prevalence of neck/shoulder pain reported in the United States has increased dramatically during the past two decades. The purpose of this randomized controlled intervention study was to examine the impact of a comprehensive office ergonomics training combined with a sit-stand adjustable workstation, under varying workloads levels, on outcomes related to discomfort, computing behaviors, and performance.

### Methods:

Participants were randomly assigned to one of the training conditions: Ergonomics Training (n=11) and No-Training (n=11) and performed a customer service job. The ergonomics training consisted of two phases: a 1.5-hour interactive in-class instruction and a sit/stand practice period, with periodic ergonomic reminders. The No-training group was given a sham training involving a brief orientation of the workstation features. The experimental task was a simulated Customer Service Representative (CSR) job based on call center service jobs. Participants were trained on the task for 4 days and reached a required proficiency level. This was a nineteen day experiment including four pre-experimental task training days and fifteen, 8 hours per day, experimental days. All participants completed a baseline and 7 hourly musculoskeletal symptoms questionnaires daily where they rated their level of pain/discomfort on a 10-point scale with 8 evenly spaced descriptors for a total of 57 body regions (Corlett & Bishop 1976).

### Results:

Our findings indicate the No-trained group experienced a significantly higher number of musculoskeletal symptoms compared to the Ergonomic trained group and the symptom reporting persisted over the 15 days. We also observed an early onset of significant musculoskeletal discomfort reports on Day 3 for the No-trained group. In contrast, musculoskeletal symptoms were minimized for the Ergonomic trained group overall, and this pattern was relatively stable over the 15 days. Quality of performance, defined by accuracy scores, was significantly higher for the Trained group compared to the No-trained group.

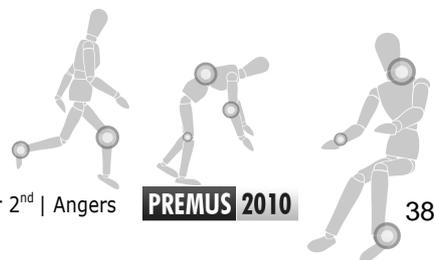
### Conclusion:

This study suggests that an office ergonomics training program, in conjunction with a sit-stand workstation, is effective in preventing the cumulative effects of musculoskeletal symptoms. Due to the significant knowledge gained from the ergonomics training and the provision of an adjustable sit-stand workstation, participants were able to effectively transfer the training to appropriately change and adjust their workstation to mitigate symptoms, adopt healthy computing behaviors and enhance their performance.

**Keywords:** Postures, physical exposure, Computer work, Intervention studies

### Reference:

Corlett, E.N., Bishop, R.P., 1976, A technique for assessing postural discomfort. *Ergonomics* 12 (2), 175-182.



## EFFECTS OF PRISMATIC GLASSES, ON POSTURES, PERCEIVED EXERTION AND COMFORT, DURING DENTAL WORK.

LINDEGÅRD A., GUSTAFSSON M., HANSSON G.Å.

*Institute of Stress Medicine, SE-413 19 Gothenburg, Sweden*

### Aims:

Dental work implies awkward and static working postures. Head flexion as well as high perceived exertion is associated with an increased risk of upper extremity musculoskeletal disorders (UEMSD). The aim of this intervention study was to explore the effect of using prismatic glasses during dental work, on head and upper extremity postures, perceived exertion and comfort.

### Methods:

Sixty subjects were invited to participate, and 46 of them, 31 dentists and 15 dental hygienists, agreed to participate. All participants underwent a comprehensive 1.5 hour information session concerning dental ergonomics, working postures, working technique and visual ergonomics.

Baseline assessments of head flexion and upper arm elevation were made during approximately 30 minutes of work in the oral cavity, on actual patient, using inclinometers. After the work perceived exertion was measured on a modified 0-14 Borg scale and comfort on a 9th graded scale ranging from -4 to +4.

Participants were randomised into an intervention and a control group. Subjects in the intervention group were sent to an optician where individually tailored glasses with prismatic lenses were prescribed and manufactured. The prisms refract the visual angle by approximately 5°.

Follow up assessments were made 8-10 weeks after the first week of usage of the prismatic glasses in the intervention group, and for the control group 8-10 weeks after the ergonomic information.

### Results:

At baseline the median head flexion was on average for all subjects 40°. Preliminary results, not including all subjects, indicate that the control group had reduced their flexion by about 2°, and the intervention group by about 5°. Hence the ergonomic information reduced head flexion by about 2° and the additional effect of the prismatic lenses was about 3°. Regarding perceived exertion the result indicates that both groups reported less exertion at follow up but no significant differences were seen between the groups. For comfort there were no differences between the control group and the intervention group and moreover no differences between baseline and follow up within the groups.

### Conclusion:

The size of the reduction of head flexion accomplished by this intervention is likely to reduce the risk for UEMSD. Part of the effect ascribed to the prismatic glasses may be due to the additional ergonomic information and the visual control and correction provided for the intervention group in conjunction with the customising of their glasses.

**Keywords:** Postures, physical exposure, health care workers, intervention studies

### References:

Ariëns GAM, Bongers PM, Hoogendoorn WE, van der Wal G, van Mechelen W. High physical and psychosocial load at work and sickness absence due to neck pain. *Scand J work Environ Health*. 2002;28:222-31.  
Hansson G-Å, Balogh I, Ohlsson K, Granqvist L, Nordander C, Arvidsson I, Åkesson I, Unge J, Rittner R, Strömberg U, Skerfving S. Physical workload in various types of work: Part II. Neck, shoulder and upper arm. *Int J Ind Ergon* (2009), doi:10.1016/j.ergon.2009.11.002.  
Lindegård Andersson A. Working technique during computer work – Associations with biomechanical and psychological strain, neck and upper extremity musculoskeletal symptoms (Thesis). 2007.



## PAINFULNESS AT THE WORKSTATION AND PREVENTION OF EXPOSURE TO MSD RISK FACTORS IN A CAR MANUFACTURER

MORAIS. A., ARABI. F.H.

PSA Peugeot Citroen, Service Industrial Ergonomics, Poissy, France

### Aims:

The goal of this presentation was to show how a large manufacturing company had evaluate to change from global assessment of the physical workload at the workstation to the assessment and prevention of the exposure to MSD risk factors by adding the mental and organisational aspects to the physical aspects of the work.

### Methods:

Industrial ergonomics has been extensively developed in the Group PSA Peugeot Citroen for more than 10 years. The initial objective was the reduction of the global physical load at the workstation, and this for three reasons: preserving the health of the operators, enhancing their performance, and managing the population age pyramid. To achieve this goal with the highest number of participants, an agreement was signed between the management of the human resources (DRH) of the Group and the main trade unions of the company targeting 8% of heavy stations and 60% of light stations. The reduction of the physical load is reflected by the decrease from 35% of heavy stations in 1999 to 10% at the end of 2009.

In spite of this progress with respect to the physical load, new complaints appeared, with a more diffuse character and strongly relayed by the media. They mostly concerned mental, psychosocial and organisational painfulness with a slight increase of the MSDs.

The first exploratory studies showed that the ergonomist's work should go beyond the physical aspect to consider the global aspects of the constraints and requirements at the workstation

### Results:

In methodological terms, a change of paradigm proves to be necessary. It is expressed in the change of approach to the notion of painfulness of operators at the work:

- The cartographic approach of the stations aims at following the agreement signed with the trade unions. This approach is possible since the energy consumption is defined from the triplet "posture, effort, frequency" based on a deterministic relation between posture-effort and the level of painfulness.
- The approach on triggering event reflects in fact the traditional approach in ergonomics of activity analysis component but also the relations within the work group, the social climate, etc... We are in the presence of a multifactorial and probabilistic approach and we can thus tackle the issue of the MSDs.

Our presentation will involve concrete examples on the collection modes and data analysis, as well as the results obtained.

### Conclusion:

Currently, we are in the phase of the implementation of the method and the techniques for the prevention of exposure to MSD risks in a large company.

**Keywords:** Postures, physical exposure, Personal risk factors for MSD, Early prevention.



## USING NORDIC STYLE QUESTIONNAIRE IN A MULTIDISCIPLINARY AND PARTICIPATIVE APPROACH FOR PREVENTION OF MUSCULOSKELETAL DISORDERS, A SUSTAINABLE OCCUPATIONAL PREVENTION TOOL?

BEAUMONT D.<sup>1</sup>, STERDYNIAK J.M.<sup>2</sup>, DOUBRE S.<sup>1</sup>, PARISE F.<sup>2</sup>

<sup>1</sup> CRAMIF (Regional Health Insurance Fund for Ile-de-France), Paris, France – <sup>2</sup> AMET (Occupational Health Service), Rosny, France

### Aims:

Using Nordic questionnaire in an occupational health or ergonomic context has been proposed for preventing musculoskeletal disorders since 1987 [1].

This questionnaire has been translated in numerous countries. In France, teams have pointed out its interest for epidemiological survey, only few publications have reported its use in workplace interventions [2, 3].

The aim of our study is to highlight the feasibility of Nordic Questionnaire associated with an ergonomic intervention to initiate a preventive and participative approach.

### Methods:

CRAMIF and Occupational Health Services introduce partnerships and set out accordingly multidisciplinary prevention actions. Our study presents a pilot action implemented in a nursing home located in Paris area and using the Nordic Questionnaire. This action was jointly conducted by occupational physicians and ergonomics. Health data were recorded by interview and completed with questions about tasks, gestures generating symptoms, and suggestions to improve working environment. Anonymity of data and return of results in workplace were guaranteed. A second step included ergonomic observation of tasks identified as most at risk and an action plan.

### Results:

32 workers were present and interviewed. 25 (78%) reported musculoskeletal symptoms during the past year. Low back (23 times) and shoulders pains (13 times) were the more frequently cited. Tasks and gestures more often reported as generating symptoms were resident's transfers and toilets, cleaning and laundry activities.

The collective report of results opened a debate about practices, health and job issues. It was followed by the setting up of a working group gathering representatives of the various jobs and functions. This group implemented an actions program with concrete realizations: improvement of laundry process, design of a new laundry area, better cleaning conditions, training of two tutors in charge of handling aid, redefining of some tasks.

### Conclusion:

The working group involved in the project used results of questionnaire in a participative and preventive approach, allowing evolution of demands, mostly initially focusing on lumbar belts, towards other issues like better health, job and career opportunities. Noticeable improvements have been brought both for workers and residents. The multidisciplinary dimension of the team was a favourable element. We used the same process in other fields, with comparable findings (food, asbestos removal, airport, hotels). However, the assessment modalities of the intervention are still discussed: interest and limits of a subsequent survey conducted in the future in same conditions, relevancy and meaning of health indicators to assess interventions for MSD prevention.

**Keywords:** Work organization, Early prevention, Intervention methods

### References:

- [1] Kuorinka I, Jonsson B., Kilbom A., Vinterberg H., Biering-Sorensen F., Andersson G., Jorgensen K. Standardized Nordic Questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics* 1987, 18.3, 233-237
- [2] Descatha A., Roquelaure Y, Chastang J.F., Evanoff B., Melchior M., Mariot C., Ha C., Imbernon E., Goldberg M., Leclerc A. Validity of Nordic-style questionnaires in the surveillance of upper-limb work-related musculoskeletal disorders. *Scand J Work En*
- [3] Coutarel F., Daniellou F., Dugué B., Landry A., Caroly S., Roquelaure Y., Douillet P., Sustainable prevention of musculoskeletal disorders : a project on assessment of the efficiency of interventions. *International Ergonomics Association Congress*, Maas



## MUSCULOSKELETAL SYMPTOMS AND JOB-RELATED FACTORS AMONG WORKERS FROM AN INDUSTRIAL SECTOR

COLUCI M.Z.O., ALEXANDRE N.M.C.

*Department of Nursing, Faculty of Medical Sciences, University of Campinas - UNICAMP, Campinas, SP, Brazil*

### Aims:

This study aimed to compare the perception of risk factors at work among workers with and without musculoskeletal symptoms.

### Methods:

The study was performed in the production sectors of two metallurgical industries located in a city in the state of Sao Paulo, Brazil. Data were collected during the working day, using the following self-administered instruments: Identification Data, Nordic questionnaire for musculoskeletal symptoms and the adapted version of the Job Factors Questionnaire. Descriptive analysis was performed and the Mann-Whitney test was used to compare the perception of job factors among a group of subjects with musculoskeletal pain and a group of subjects without symptoms, according to Nordic questionnaire.

### Results:

The study included 106 subjects with mean age  $35 \pm 11.5$  years and 99.1% were male. The results showed that workers indicated a higher percentage of pain during the previous 12 months in the lumbar region (38.7%), followed by the thoracic, knees and ankles/feet. The activities perceived as most responsible for the appearance of pain or injury were those involving static muscular work, bending or twisting the back, working in cramped positions, and working with pain. The Mann-Whitney test demonstrated that there was a significant difference (p

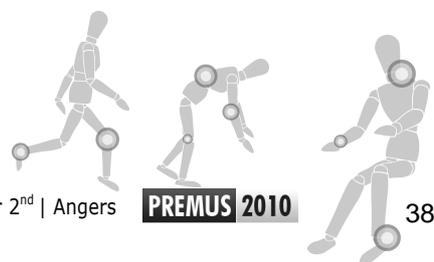
### Conclusion:

It is important to investigate the relationship between work-related factors and the appearance of symptoms because musculoskeletal disorders are the leading causes of disability and absence from work in many occupational groups (Merlino et al., 2003). The analysis of the results indicated a significant agreement between the presence of musculoskeletal symptoms and the workers' perception of the work factors that they believe could lead to job-related pain and discomfort. The data showed that the greater the problem stated in each item of the instrument on job factors, the higher the presence of pain on the body map of the Nordic Questionnaire. This suggests that the job factors questionnaire was able to collect information regarding employees' perceptions of job factors that could lead to the development of musculoskeletal disorders, as observed by others (Rosecrance et al. 2002).

**Keywords:** Mechanism of pain and tissue injury, exposure measurement methods, early prevention

### References:

- Merlino L, Rosecrance JC, Anton D, Cook TM. Symptoms of musculoskeletal disorders among apprentice construction workers. *Appl Occup Environ Hyg.* 2003;18(1):57-64.  
Rosecrance JC, Cook TM, Zimmermann CL. Test-retest reliability of a self-administered musculoskeletal symptoms and job factors questionnaire used in ergonomics research. *Appl Occup Environ Hyg.* 2002;17(9):613-21.



## ADJUSTABLE CARTS: AN EFFECTIVE INTERVENTION FOR REDUCING THE LOW BACK INJURY RISK FOR GROCERY STOCKERS

DAVIS K.G., ORTA-ANÉS L.

University of Cincinnati, Cincinnati, Ohio and University of Puerto Rico-Medical Sciences Campus, San Juan, Puerto Rico

### Aims:

Musculoskeletal disorders are prevalent in grocery stores in the United States (more than 20,000 cases per year), with the majority being attributed to lifting of product (BLS, 2009). The aim of the study was to determine effectiveness of an adjustable cart to reduce awkward trunk motions and risk of low back injuries while stocking products in a grocery store.

### Methods:

Fifteen Spanish-speaking workers at a small grocery store in Puerto Rico completed traditional stocking tasks with two types of carts: traditional and adjustable height cart (Ergo Cart). Four different stocking tasks were evaluated: 1) loading cart with 2-liter soda pop bottles, 2) loading cart with dog food bags, 3) loading cart with 12-can boxes of soup, and 4) unloading cart of 12-cans packages of soda pop. Three-dimensional trunk position and velocity were measured by the lumbar motion monitor. The total time to complete the individual stocking tasks and corresponding rating of perceived exertion were collected. Continuous independent variables were statistically analyzed with split-plot repeated measures ANOVA while Kruskal-Wallis one-way ANOVA was utilized for discrete variables.

### Results:

The Ergo Cart reduced the sagittal trunk flexion by 23% and velocity by 17% but its size configuration increased twisting by 26% and twist velocity by 11% as compared to the traditional cart. The LBD risk index was reduced by a small 2.4% probability in high-risk group membership. The consensus among workers was that the adjustable cart required less physical exertion with small increases in productivity.

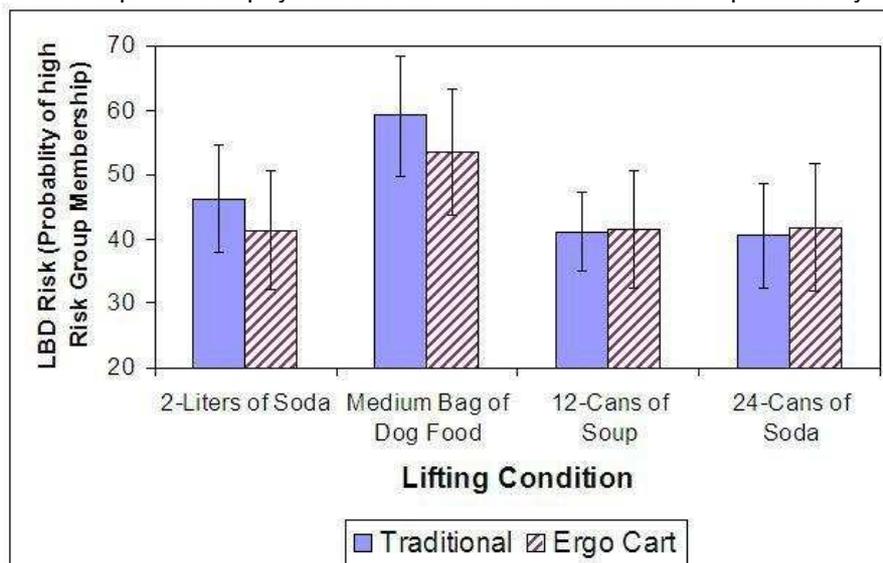


Figure: LBD Risk index as a function of Task Condition and Intervention

### Conclusion:

The study provides solid evidence that proper ergonomic design (e.g. lifting from waist height through adjustable height cart) may reduce many of the awkward trunk motions during stocking activities without negatively affecting productivity. However, the location and better maneuverability of the Ergo Cart could increase trunk twist motions.

**Keywords:** Postures, Physical exposure, Intervention studies, Back, Low back

### Reference:

Bureau of Labor and Statistics, Number of nonfatal occupational injuries and illnesses with days away from work involving musculoskeletal disorders by selected natures and events or exposures, grocery stores, 2000, <http://www.bls.gov/opub/cwc/tables/sh20>



## DOES STATISTICALLY SIGNIFICANT REDUCTION IN PAIN LEAD TO RELEVANT IMPROVEMENTS IN FUNCTIONAL OUTCOMES AFTER WORKPLACE EXERCISE FOR CONTROLLING PAIN? A SYSTEMATIC REVIEW.

MOREIRA R.F.C., DIAS N.B., COURY H.J.C.G.

*Physiotherapy Department, Federal University of São Carlos, São Carlos, SP, Brazil*

### **Aims:**

Pain is considered to be one of the more common symptoms related to musculoskeletal disorders. Functional alterations might follow chronic pain. One of the measures applied for controlling these negative healthy outcomes is workplace physical exercises. Statistical tests are used to assess the effectiveness of interventions for pain relief. However it is not clear how these results are associated with clinically relevant functional improvements. Thus, this review assesses and provides evidence regarding the relationship between statistical reduction in pain and functional improvements after workplace exercise interventions.

### **Methods:**

The following databases were consulted: PubMed, MEDLINE, Embase, Cochrane, PEDro and Web of Science. Two independent reviewers selected the eligible randomized controlled trials (RCTs) and possible disagreements were solved by consensus. Only studies reporting measurable dimensions of pain (scales, questionnaires and algometry) and functional variables (sick leave, absenteeism, range of motion, muscle strength, EMG, heart frequency and VO<sub>2</sub>) were included. The PEDro scale was used to rate the methodological quality of the included RCTs.

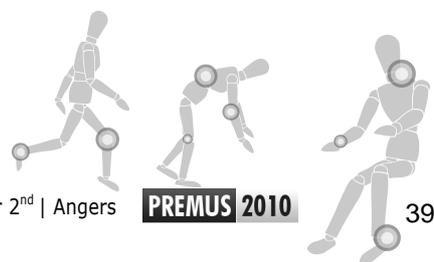
### **Results:**

The electronic search yielded a total of 8680 references published in English. At the end of the selection process 13 RCTs were included. Strong evidence was found to support the positive relationship between pain and functional outcomes. From 13 RCTs, 12 showed concordance between pain and functional results, with 6 reporting positive results for pain and functional variables, whilst 6 other studies reported negative results for both outcomes. Differences in exercise protocols and body regions affected seem to explain the discrepancies between positive and negative results obtained by the interventions implemented.

### **Conclusion:**

In general, the descriptive differences between pre and post interventions could be considered clinically small, particularly for the pain results. Possibly, this could be explained by the fact that the participants were working regularly during the interventions, and were already presenting small levels of pain at the pre intervention period. Despite that, it seems positive that some of the exercise protocols were able to promote improvements in both outcomes evaluated. Finally, strong evidence was identified to support a positive association between pain relief and functional improvements.

**Keywords:** Early prevention, Intervention studies, Pain, Chronic pain



## REDUCING MUSCULOSKELETAL DISORDERS AMONG DENTIST OPERATORS: AN ERGONOMIC INTERVENTION APPROACH TO IMPROVE WORKING CONDITIONS

DEHDASHTI A.R., KHAVANIN A., MORTAZAVI S.B.

*Semnan University of Medical Sciences, Iran*

### **Aims:**

This study aimed to evaluate the impact of an ergonomic intervention in reducing musculoskeletal disorders among dental health care workers. The study was carried out in various departments of a high specialized dental clinic in Tehran.

### **Methods:**

We used Nordic standard questionnaire to collect relevant information on operators' musculoskeletal complaints. Subjects' working posture was assessed by Rapid Entire Body Assessment technique (REBA). 47 dentists including 37 male and 10 female subjects participated in the study.

### **Results:**

We found that around 80 percent of subjects experienced at least signs of discomfort in their limbs, interfered with activities of work or daily lives. Most complaints were from neck (83 percent) and shoulder (62 percent). 10-15 percent of dentists in various departments had work-related absenteeism. Rapid Entire Body Assessment technique indicated that 94 percent of operators were above moderate risk condition. priority level for investigation and job modification was determined as necessary for 60 percent immediately necessary for 34 percent of dentists.

To accomplish job modification, operators received training on the basis of a human-centered ergonomic approach also known as "performance logic". This approach allowed dentist operators to apply the most reasonable procedures to carry out their relevant tasks. Accordingly operators were able to fit their work posture, patient position and equipment in a manner to prevent work related risk and improve his/her work efficiency.

Following intervention we found significant decrease in the incidence of musculoskeletal complaints in the neck and shoulders ( $p < 0.05$ ). However, there was no significant improvement in lower back pain among participants.

### **Conclusion:**

We concluded that intervention measures may lead to significant improvement in lowering musculoskeletal risks as determined by Rapid Entire Body Assessment.

**Keywords:** Exposure measurement methods, Intervention methods, Other

### **References:**

Hignett S., Atamney L. Rapid Entire Body Assessment (REBA). *Applied Ergonomics*. 2000;31: 201-205.  
Rucker LM, Sunell S. Ergonomics Risk Factors Associated With Clinical Dentistry. *J Can Dent Assoc*. 2002;30:139-148



## STRATEGIES FOR PREVENTION OF MSD IN A LARGE FRENCH OCCUPATIONAL HEALTH DEPARTMENT

DESARMENIEN A., BIDRON P.

*Santé au Travail 72, Le Mans, France*

### Aims:

As part of their responsibilities for protection of the health of the working population, Occupational Health Departments are being required to develop a series of measures for the prevention of MSDs at various levels.

### Methods:

Primary prevention:

- Primary prevention involves adapting work activities before damage and disorders can occur by providing information for the workforce and for employers, and by reduction of risk factors at source.
- Medical aspects: Provision of information for the workforce and employers on the risks of MSDs by occupational health physicians and nurses (disorders and damage, early clinical warning signs, risk factors), reference medical examination at start of employment, periodic medical follow-up of employees.
- Technical aspects: Design of work situations by researching the anticipation and control of risk factors (respect for anthropological norms, improvement of work stations and development of work organisation facilitating performance of activities.)
- Case study to be presented: process of designing an individual cheese portion manufacturing workstation.

Secondary prevention:

- Once the occurrence of an MSD has been detected there should be intensive medical screening of the workforce and intervention in the workplace in order to control and reduce the risk of MSDs.
- Medical aspects: Referral of employee(s) to a treatment centre for evaluation and treatment, medical follow-up by occupational health physicians and nurses, information gathering.
- Technical aspects: Analysis of work situations responsible for MSDs, identification of risk factors in order to change them.
- Case study to be presented: the "MSD 72 Action" program in a French region with long-term prevention of MSDs.

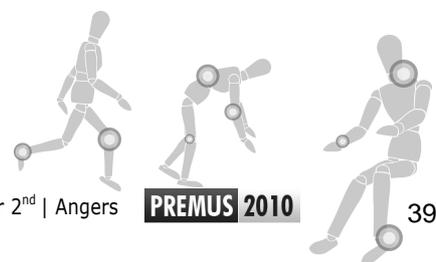
Tertiary prevention:

- The aim of actions at this level is to maintain employees at their workstations
- Medical aspects: Medical follow-up with the possibility of declaring a restriction of the capacity of exposure to work constraints in order to protect the employee;
- Technical aspects: Research into and proposal of technical and organisational adaptations of the employee's work situation.
- Case study to be presented: the "ST-MS" (Occupational Health – Upper Limbs) return to work program combining physical rehabilitation and intervention in the workplace.

### Conclusion:

The combination of all these activities permits the Occupational Health Departments to assist companies in the control of risk of MSDs

**Keywords:** Surveillance, Early prevention, Intervention methods.



**ERGODISTRIB: A NATIONAL, MULTIDISCIPLINARY STUDY FOR THE PREVENTION OF MUSCULOSKELETAL DISORDERS OF THE UPPER LIMBS AND SPINE IN PARTNERSHIP WITH MANAGEMENT REPRESENTATIVES OF THE MAIN FRENCH FOOD DISTRIBUTORS**

VIOSAT M., BOITEL L., BOULOT M., INCORVAIA A.M., JEANCOLAS B., RAT DE COQUARD M., DESARMENIEN A., DUPERY M.

*Groupe ergonomie, département ASMT, CISME (France)*

**Aims:**

Occupational Health physicians often find employees of large distribution chains reporting significant levels of musculoskeletal disorders (MSDs) of the upper limbs and spine, with increased recording of work-related disease. Managers lay emphasis on absenteeism, frequency of work accidents and work-related disorders and increased levels of restricted skills and work ability, and the costs and difficulties they engender. A two-level study was undertaken to assess both the health status according to socio-economic characteristics, nature of the job and characteristics of the shop and the work and the work condition by in site job analysis.

**Methods:**

All categories of employees (apart from cashiers), all food departments, and all shop types were included. Each participating physician offered the anonymous questionnaire to the first twenty employees seen in consultation. Nine anatomic regions were investigated, with questions on pain, stiffness or difficulties impacting on working life. Data processing was performed using EPI-DATA®. The ergonomic analysis was based on study of the working environment using observation check-lists designed specifically to describe, quantify and identify determinants of constraints. Employees and investigators could suggest ways in which these might be improved. Four hundred physicians distributed 4821 questionnaires, and 292 physicians and 129 ergonomists undertook 348 job analyses.

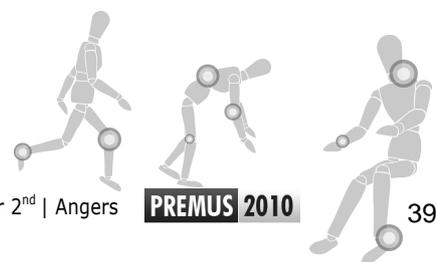
**Results:**

Seventy-five percent of participating employees reported repetitive movements, and hand, wrist and spine constraints. Eight in ten employees were satisfied with their work. The cervical and lumbar spine, wrists and shoulders were the main sites of pain (prevalence 30% - 60%), often causing difficulties in working and recourse to treatment. The results varied according to the type of shop and department. The results of the ergonomic analysis were in agreement with those of the epidemiological study, identifying organisational and/or technical parameters determining the constraints according to activity and department.

**Conclusion:**

This study gathered together a collection of preventive measures related to MSDs in an approach developed with management. It has made it possible to define axes of prevention related to information technology, organisation and equipment. The acceptance of these proposals by the management levels has led to concrete action and stabilisation of the numbers of workers reporting these disorders.

**Keywords:** Specific sectors, Epidemiology, Intervention methods.



## THE EFFECT OF A SHOULDER PAD ON SHOULDER COMPLAINTS AND PRODUCTIVITY IN SCAFFOLDERS

VAN DEN BERG T.I.J., ELDERS L.A.M., BURDORF A.

*Department of Public Health, Erasmus Medical Centre Rotterdam, The Netherlands*

### Aims:

This pilot study was conducted to evaluate the implementation of a shoulder pad with regard to shoulder complaints and productivity among scaffolders. Scaffolding is a well-known occupation for shoulder complaints. Scaffolders often carry heavy materials on their shoulders. The force applied on the shoulder during horizontal transport may exceed 25 kg. This point pressure could cause nerve conflicted shoulder complaints. Elders et al. (2001) reported an occupational injury in scaffolders who suffered from serratus anterior paralysis after carrying excess load on the shoulder. In order to prevent specific work related shoulder disorders, it has been suggested to enlarge the contact area on the shoulder and decrease the point pressure by wearing a shoulder pad.

### Methods:

Both before and after implementation a questionnaire and diary were used to assess compliance to the intervention, presence and severity of shoulder complaints, productivity and perceived comfort and usability of the shoulder pad. After 1 and 3 months post-intervention measurements were taken. Subjects were selected from two large scaffolding companies in the Netherlands. A mixed model analysis was used to identify the effects of the intervention on the three outcome variables.

### Results:

During the follow-up 14 respondents (22.6%) did not participate in the first post-intervention diary and an additional 8 respondents (12.9%) did not participate in the second post-intervention diary. In total, 40 respondents participated in all three measurements. The results show that the average pain severity and productivity decreased over time, with a significant reduction after 3 to 7 month use of the intervention. The experienced physical load remained unchanged. With respect tot compliance to the intervention, those workers with complete compliance during follow-up reported a reduced pain intensity of 1.75 (0.13-3.3.8) points. Compliance was independent of self-reported physical load and productivity. Subjects valued the shoulder pad with a mean mark of 7 on a 10-point scale varying between 0 'not satisfied' and 10 'very satisfied'. After complete follow-up 55.3% of the users believe that the shoulder pad reduces shoulder complaints. Whereas 54.0% of the users think that the shoulder pad should be included in the standard equipment.

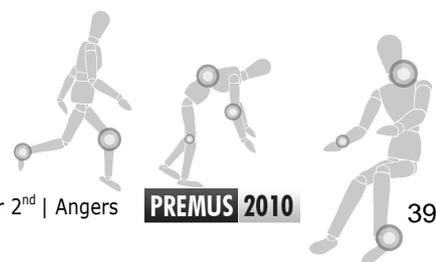
### Conclusion:

Four months use of the shoulder pad significantly reduces pain severity among scaffolders. Self-reported productivity was also reduced, whereas no effect was found for self-reported physical load. The results of a recently performed study in Belgium seem to be even more promising.

**Keywords:** Intervention studies, disability prevention, pain, chronic pain

### Reference:

Elders LAM, Van der Meché, F.G.A., Burdorf A. Serratus anterior paralysis as an occupational injury in scaffolders: two case reports AJIM 2001; 40: 710-713



## THE DEVELOPMENT OF "MUSKA" AS TOOL TO SUPPORT A LONG LASTING MSD PREVENTION IN THE WORPLACE

ESCRIVA E.<sup>1</sup>, MERLIN X.<sup>2</sup>, THIBAUT J.F.<sup>2</sup>

<sup>1</sup> National Agency for the Improvement of working conditions (ANACT), Lyon, France – <sup>2</sup> Regional Association of Aquitaine (ARACT Aquitaine), Bordeaux, France.

### Aims:

"MUSKA" is a tool designed to estimate and simulate MSD risk in a wide range of organizations. This tool provides quantified data stemming from activity observations. Used within a participative occupational health program, it allows, one hand, the objectification of MSD exposure, and other hand, the search and sharing of improvements.

### Methods:

First step is to define a description protocol related to the operations performed on a working cycle. A computer application processes the data recorded by video. The assessment is based on quantifying biomechanical criteria (articular positions, efforts, thermal environment, vibrations, duration and frequency of the effort, phases of recovery). A resulting synthetic score indicates a level on a scale from 1 to 4 for the upper limbs as a whole and the back.

This tool is used in key MSD prevention steps:

- To estimate the MSD risks as part of comprehensive work situations analysis,
- To simulate impacts of technical and organizational solutions and therefore retain the least exposure,
- To evaluate MSD risk after change.

The user is trained to activity analysis to insure the relevance of protocol, the quality of interpreting and sharing results with the company stakeholders.

### Results:

A MUSKA's first version was used in 2001 in an automotive assembly plant. It was adapted to evaluate the cumulative risk resulting from different rotating combinations [1]. Now, occupational health services and OSH institutions are experimenting a new version applied in small companies (crafts, farming, building, etc.) of the Aquitaine region. Its profit as part of MSD prevention depends on socially negotiated interpretations as well as additional qualitative investigations [2]. Such a comprehensive approach is conducive to a collective development of prevention project, especially in SMEs [3]. Moreover, the measurement interest relies mainly in the comparison between observed sequences. Video recording reveals that workers adopt differentiated gestures, this provides support to discuss intentions and compromises that lead them. This material can enrich job description and training. Finally, select a rotating combination by simulating, also needs consensus on the final score of the posts, possible improvements of the workstation, the time required for learning and the feasibility of implementing.

### Conclusion:

MUSKA can identify the most strenuous operations and proposes a synthetic score of MSD risk. It can also simulate the impact of changes and, thus, contributes to informed investments. As any measurement tool, it requires caution, so as to fully develop its interface quality between the company actors.

**Keywords:** Work organization, Exposure measurement methods, Intervention methods.

### References:

[1] Thibault (J.F.), Le Trequesser (R.), Guglielmina (J.), Leconte (S.), Labrot (N.) - "Développement de l'outil MUSKA dans le cadre d'une démarche pluridisciplinaire de gestion du risque TMS par la rotation", in "Actes du 1er congrès francophone sur les TMS du membre supérieur, Nancy, 30 et 31 Mai 2005", INSTITUT NATIONAL DE RECHERCHE ET DE SECURITE, 2005, 7 pages

[2] Caroly (S.), Coutarel (F.), Escriva (E.), Roquelaura (Y.), Schweitzer (J.-M.), Daniellou (F.) (Coordinateur) - "La prévention durable des TMS. Quels freins? Quels leviers d'action?, Rapport DGT recherche-action 2004-2007", EDITIONS DE L'ANACT, 01/2008, 180 pages

[3] Merlin (X.), Thibault (J.-F.) - " La prévention des risques professionnels chez les artisans shaper : démarche d'intervention et outils de simulation organisationnelle", in "Ergonomie et Organisation du travail, 44e congrès de la Société d'Ergonomie de Langue Française, Toulouse les 22, 23, 24 septembre 2009" / Gaillard (I.), KERGUELEN (A.), THON (P.) - SOCIETE D'ERGONOMIE DE LANGUE FRANCAISE, 2009, pp. 39-46



## HAND TOOL DESIGN AND ERGONOMICS: DESIGN OF A NEW HAMMER FOR SLATERS

GOUBAUD S.<sup>1</sup>, ASSELIN A.<sup>2</sup>

<sup>1</sup> Dimos, Ancenis, France - <sup>2</sup> Direction Régionale des Risques Professionnels de la Caisse Régionale d'Assurance Maladie d'Île de France, Paris, France, DIMOS, Ancenis, France

### Aims:

When fitting a roof covering the roofer's hammer is used 80% of the time. DIMOS, manufacturer of equipment for roofers, has developed a tool combining technological innovation (fabrication) and ergonomic design (concept). The project involved end-users in order to ensure:

- improved comfort in holding the tool, with a reduction in the risk of injury. A multifunction tool, the hammer can be used for trimming, cutting holes, nailing slates, and pulling out nails; each action requiring a different method of holding.
- reduction in the risk of musculoskeletal disorder. Forces, movements, shock and vibration expose roofers to epicondylitis, carpal tunnel syndrome and osteonecrosis of the lunate (Kienbock's disease). Occupational disease statistics and symptomatic pain confirm these risks.

### Methods:

A panel of users participated in analysis of the requirement, in the prototype evaluation stages, and in validation of the product.

After analysis of the traditional tools, user requirements and the ergonomic targets for the tool, design focused on:

- improving the shape and material of the handle (adaptation to roofers hands and holding, distribution of pressure, and damping of shock and vibration),
- adjusting and optimising the weight and balance of the tool (according to the thickness and hardness of the slates, accuracy, reduction in force needed and repetitiveness),
- selecting grades of materials and heat treatments, optimising resonant frequencies, and the position of the centre of gravity (reduction in vibration).

Prototyping techniques made it possible to test and optimise each characteristic. The data gathered was used to determine the methods for assessing ergonomics (study of the activity, observations, psycho-physical tests, studies into hand–handle contact ...).

### Results:

Tests at the end of the project have validated the design and confirmed that users appreciate the tool's qualities (comfort, safe handling, absence of vibration, balance, functionality, good adaptation to the weight of the slate thanks to a removable weight).

### Conclusion:

Short-duration user tests (from a few hours to 16 days) made it possible to develop the design of the tool but final validation is now required from data generated by long-term use. The product has been on sale since the beginning of 2007. Roofers using it, with priority given to the youngest, found that the tool was comfortable to use and well-adapted to the hand. Sales results are a reliable proof of this.

**Keywords:** Postures, physical exposure, Construction, Early prevention.



## A MACRO-ERGONOMIC APPROACH TO INJURY PREVENTION

HOFFMEISTER K., SCHWATKA N.V., ROSECRANCE J.C.

Colorado State University, Fort Collins, CO, USA

### Aims:

Safety climate, and the employee perceptions and behaviors that accompany it, are components of the personnel subsystem within a macro-ergonomic framework, which can ultimately affect various micro-ergonomic outcomes. The present study used macro-ergonomic concepts to examine an early prevention method aimed at reducing workplace injuries. The focus of this method was the psychosocial construct of safety climate, a significant leading indicator of injuries within the workplace.

### Methods:

Employees (n=56) from a craft brewery in the United States were surveyed regarding safety climate and work-related injuries. Summary statistics revealed that baseline safety climate scores were very high throughout the facility, with mean scores falling near or above 75% of the highest possible score.

### Results:

No statistically significant correlation was found between safety climate and injury rates. Perceptions of safety climate did not significantly differ between departments. The company's injury and illness rates generally follow a decreasing 13-year national trend for their industry using standardized injury reporting statistics from the US governmental occupational safety and health administration. Recently, however, their amount of recorded injuries was higher than the industry average, and their amount of lost workdays was lower.

### Conclusion:

Although the results did not support the hypothesis that safety climate would differ between departments, these findings suggest a high level of safety climate throughout the organization. The consistency of the company's safety climate across departments indicates that management exhibits commitment to safety equally across the company. Such commitment may indicate that new safety initiatives within the company will have a high probability of success. Furthermore, the higher amount of recorded injuries in this company compared to the industry average may be the result of following industry reporting standards. The company's encouragement for employees to report early symptoms of injuries or illnesses could contribute to this discrepancy. Although this company had a higher rate of recorded injuries, their number of lost workdays was lower than the industry average, suggesting that the injuries reported might not have been as serious. This project represented the first phase of a macro-ergonomic approach to injury prevention that integrated psychological constructs with the passive surveillance of injury data. The next step is to develop a comprehensive ergonomics process based on metrics involving safety climate, injury data, and specific physical job analyses. This interdisciplinary approach to injury prevention is consistent with

**Keywords:** Psychosocial factors, work organization, early prevention

### Reference:

Brewer, J. D. & Hsiang, S. M. (2002). The 'ergonomics paradigm.' Foundations, challenges and future directions. *Theoretical Issues in Ergonomic Science*, 3(3), 285-305.



## EFFECTIVE DISSEMINATION OF AN ERGONOMICALLY-MODIFIED BLUEBERRY RAKE

MAY J., HAWKES L., WYCKOFF S., GINLEY B., ROWLAND M.

*New York Center Agricultural Medicine and Health, Cooperstown, NY, USA*

### **Aims:**

Several studies have shown a relationship between blueberry raking and wrist, forearm, elbow and shoulder symptoms. Our group has recently reported upon a long-handled rake (LHR) modification designed by a community-based project team of workers and employers. The LHR replaces the rapid, forceful wrist abduction / adduction of the traditional harvesting rake with longer sweeping movements of the arms and shoulders. Workers consistently noted less force and less pain with the LHR. Productivity was enhanced with the LHR. The aim of this study was to assess the effort to disseminate the LHR.

### **Methods:**

Dissemination involved the design, marketing, pricing and ready access to the modification. The handles were designed for easy attachment to existing rakes with wing nuts. Paper templates were provided with the handles for each size rake to guide the drilling of four holes. The project team included one of Maine's leading blueberry rake manufacturers who produced handle sets in several lengths for \$40. In its final year, the project hired a part-time assistant to visit worker camps, explain about the findings of the project and sell / install handles for a total cost of \$20. An English /Spanish video describing the project and the advantages of the LHR was shown at a workers welcoming center at the start of the following season. Three years later, during the season of 2009, project staff assessed the use of LHR vs. traditional rakes with short interview questionnaires at randomly selected worker camps in Washington County, Maine.

### **Results:**

Of 82 workers interviewed, 60 (73%) are now using the LHR. Sixty-three percent of these began using the LHR in the past three years. None of these had obtained their handles through the project. Only a few even had any knowledge of the original project.

### **Conclusion:**

The simplicity of handle installation on existing rakes and the efforts to promote and subsidize the first generation of handles appears to have accelerated that adoption of the LHR. By prominently featuring the LHR on his website and in his catalogues, the manufacturer has likely also assisted this dissemination effort substantially. This multifaceted approach to encouraging use of the LHR appears to have been successful in the fairly rapid adoption of this ergonomic intervention.

**Keywords:** Agriculture, Intervention methods, Vulnerable workers

### **References:**

- Estill CF, Tanaka S. 1998. Ergonomic considerations of manually harvesting Maine wild blueberries. *J Agric Safety Health* 4(1):43-57.  
Millard P, Shannon S, Carvette B, Tanaka S, Halperin W. 1996. Maine students' musculoskeletal injuries attributed to harvesting blueberries. *Am J Public Health* 86(12):1821-1822  
May J, Hawkes L, Jones A, Burdick P, Ginley B, Santiago B, Rowland M. Evaluation of a community-based effort to reduce blueberry harvesting injury. *Am J Indust Med* 2008; 51(4):307-15.



## INTERVENTION AGAINST WORK-RELATED MUSCULOSKELETAL DISORDERS (WRMD) AMONG OFFICE WORKERS FROM PUBLIC SECTOR

OLIVEIRA A.B., GIL COURY H.J.C., VINGÅRD E.

*Department of Physical Therapy, Federal University of São Carlos (UFSCar), Brazil*

### Aims:

Developing and applying a preventive program to improve musculoskeletal health and work conditions of university workers and to check the effectiveness of this program.

### Methods:

The intervention group (IG, N=24, mean age=43.33±7.43years, time working at the university/current function=14.63±7.33/9.50±6.78years) was assessed before and after the intervention. Ten workers from the IG were also assessed six months after the end of the intervention (sustainability group-SG, N=10, mean age=43.33±6.50years, time working at the university/current function=15.78±4.94/9.69±6.43years). The control group (CG, N=12, mean age=42.83±10.56years, time working at the university/current function=15.00±8.54/7.45±5.54years) was composed by workers who did not receive any intervention. Nordic Musculoskeletal Questionnaire (NMQ), Utrecht Work Engagement Scale (UWES) and Job Stress Scale were applied to assess musculoskeletal symptoms and psychosocial indicators. Workers were introduced to the intervention program through a brief presentation about WRMSD, risk factors and prevention. Ergonomic Workplace Analysis (EWA) was individually applied (FIOH - Ahonen et al, 1989). Results of EWA were used to adjust each workplace. The intervention lasted from 6 to 12 months.

### Results:

EWA showed problems in workspace, lighting, thermal environment and noise. The workspace (inadequate seats, lousy leg space, inadequate or none wrist support) seems to be the main responsible for awkward postures and movement restrictions. NMQ recorded high prevalence of musculoskeletal symptoms for wrists and hands, lower back, neck, shoulders, and upper back. After the intervention there was a general reduction of symptoms for some body regions. Comparing to the CG, IG had decreased the weekly prevalence of symptoms on lower/back (21.76%) and wrist/hands (21.76%). Data for the SG are inconclusive since they had the same variation as the CG. Psychosocial risk factors identified among the workers involve low control over the working process as well as low level of compromise and vigor.

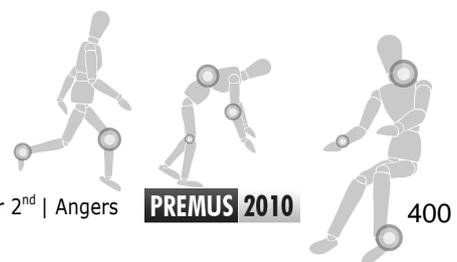
### Conclusion:

Data of intervention are not conclusive but show improvement for specific body sites. Many physical factors were improved but the current Brazilian public working system impairs the use of ergonomics. Besides, psychosocial risk factors seem to be directly related to the management model adopted by the government: the high frequency of strikes and lack of workers' promotion contribute to discourage workers. Changes on organization of the public system are needed to allow a better control of psychosocial risk factors as well as workplace design.

**Keywords:** Computer work, psychosocial factors, intervention studies

### Reference:

Ahonen M, Launis M, Kuorinka T. Ergonomic workplace analysis. Transl. by Georgianna Oja. Helsinki, Finland: Ergonomics Section Finnish Institute of Occupational Health, 1989.



## LOAD CARRIAGE: MINIMISING SOLDIER INJURIES THROUGH PHYSICAL CONDITIONING – A NARRATIVE REVIEW

ORR R.M., POPE R., JOHNSTON V., COYLE J.

*University of Queensland, Queensland, Australia*

### **Aims:**

Load carriage tasks form part of the military soldier's vocation. With research showing an increased load to be borne by soldiers, effective physical conditioning may provide one means of reducing injuries induced by carrying these heavy loads. Through a reduction in injuries, the ability to train, maintain and retain soldiers is increased. The aim of this study was to review the current literature on physical conditioning for load carriage and present the findings in a manner that allowed physical conditioning practitioners a means of applying the findings into a conditioning program.

### **Methods:**

Using key search terms, a literature search of academic databases (both civilian and military) was conducted, with additional relevant literature sought from military and civilian colleagues. Gathered papers were assessed against several key criteria, in order to exclude papers which were not relevant to the load carriage context of interest, and then limited to those papers that specifically related to physical conditioning and military load carriage. These papers were reviewed to glean key findings in the light of information from, additional sources that were employed to contextualise the findings. The additional sources were research papers and published texts utilized by physical conditioning practitioners to develop conditioning programs.

### **Results:**

The search results yielded seven original research papers, one conference paper and four secondary source papers (military reports, journal articles).

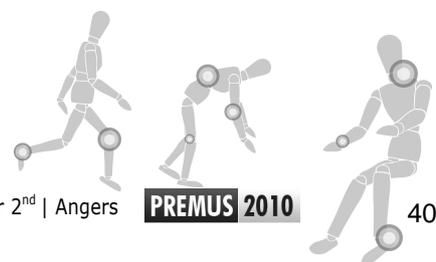
### **Conclusion:**

Research suggests that an effective physical conditioning program for load carriage will include specific load carriage training conducted between two and four times per month. While loads must be sufficient to elicit a physiological response proportionate to that recommended for the development of cardiovascular and metabolic fitness, higher intensity training may be of particular benefit. Conversely, excessive training volume may increase the risk of both acute and overuse injury risks. While other forms of conditioning may supplement a load carriage conditioning program, load carriage specific training is still needed, with the duration and distance gradually progressed to levels that meet training and operational needs.

**Keywords:** Muscle activity, Work organization, Early prevention

### **References:**

- Knapik JJ, Bahrke M, Staab J, et al. Frequency of Loaded Road March Training and Performance on a Loaded Road March. T13-90. Military Performance Division. US Army Research Institute of Environmental Medicine, Natick. 1990:52.
- Kraemer W, Vescovi JD, Volek JS, et al. Effects of concurrent resistance and aerobic training on load-bearing performance and the army physical fitness test. *Mil Med.* 2004;169(12):994-999.
- Visser T, van Dijk MJ, Collee T, et al. Is intensity of duration the key factor in march training? Paper presented at: International Congress on Soldier's Performance, 2005; Finland.



## BIOMECHANICAL METROLOGY: A SUPPORT IN OCCUPATIONAL CONTROVERSIES

SAVESCU A.<sup>1</sup>, GAUDEZ C.<sup>1</sup>, SIMONET P.<sup>2</sup>, FERNANDEZ G.<sup>2</sup>, VAN TRIER M.<sup>3</sup>, AUBLET-CUVELIER A.<sup>1</sup>, CLOT Y.<sup>2</sup>

<sup>1</sup> Biomechanics and Ergonomics Laboratory, INRS [French national health and safety research institute], Vandoeuvre-lès-Nancy, France - <sup>2</sup> CRTD (EA 4132), Clinic of activity, CNAM Paris, France - <sup>3</sup> SMPP, Paris, France

### Aims:

The multifactor nature of Work-Related Musculo-Skeletal Disorders (WRMSD) demands multidisciplinary intervention for improving prevention of these occupational diseases. A study combining biomechanics and psychology was conducted on gravediggers [1]. Its purpose was to make these operators WRMSD prevention active contributors through dialogues and occupational controversies concerning their trade gesture. This work activity was initially subjected to “clinical activity” analysis [2]. Gravediggers’ and occupational physician’s desire to pursue discussions and to gain greater understanding of the throwing backward movement prompted introduction of biomechanical metrology. The purpose of this biomechanical analysis was to provide new comprehension data, allowing gravediggers to expand and extend discussion around this specific trade gesture. The challenge for the biomechanics team was to be able to transfer the biomechanical results to the gravediggers and to thereby fulfil the intended objective.

### Methods:

Eight volunteer gravediggers took part in the biomechanical study. Activity of eight muscles, the anterior, medius and posterior left and right deltoid and the left and right lumbar muscles, was recorded by surface electromyography under real working conditions (manual digging of 1.50 – 2.00 m deep grave). These muscles were selected based on pains declared by gravediggers, clinical examination by occupational physician as well as the preliminary results provided by the “clinical activity” analysis. Each gravedigger made 60 throwing backward movement, which were filmed synchronously with biomechanical data acquisition. The muscular activity of each shoulder was assessed for each throwing backward movement by combining the activity of the three subdivision of each deltoid muscle.

### Results:

Two series, corresponding to the most and least stressing throwing backward movement, were defined for each gravedigger based on the intensities of shoulder and lumbar muscular activity. The videos of the throwing backward movement in these two series and the quantitative evaluation of the corresponding muscular stresses were then shown to the gravediggers during self- and cross-confrontations [3].

### Conclusion:

Biomechanical metrology was not only used to quantify the body movement performed in this study: result presentations also enabled gravediggers to expand their knowledge of the rearward throwing movement and, thereby, to discuss it in greater depth. New occupational controversies could be developed on the strength of this. The work allowed the group of gravediggers to become a fresh source of proposals for extending the possibilities of performing this throwing backward movement.

**Keywords:** Biomechanics, Intervention methods, Upper limb

### References:

- Aptel, M., & Gaudez, C. Plausibilité biologique du lien entre les TMS et le stress. Proceedings of 1st Francophone Conference on upper limb MSD. 30th - 31st May 2005, Nancy, France.  
Clot Y. Clinic of activity: dialogue as an instrument in learning and expanding with activity theory. Edited by Sannino A., Daniels H., Gutiérrez K.D., © Cambridge University Press 2009  
Mollo V., Falzon P. Auto- and allo-confrontation as tools for reflective activities, Applied Ergonomics, 2004, vol. 35, no6, pp. 531-540



## **SURVEILLANCE FOR MITIGATION OF OCCUPATIONAL HEALTH HAZARDS AND MUSCULOSKELETAL PROBLEMS OF AGRICULTURAL WORKERS THROUGH EDUCATIONAL INTERVENTION**

VYAS REKHA

Associate Professor-FRM, Directorate of Extension Education, MPUAT, Udaipur (Raj.), INDIA

### **Aims:**

Assessment of the types of occupational health hazards confronted by the agricultural workers and incidence of musculoskeletal problems and body discomfort during agricultural work so that an educational intervention can be developed for creating awareness regarding hazards and safety in agriculture work and thereby mitigating their health and musculoskeletal problems.

### **Methods:**

A survey to find the comprehensive portrayal of the type of health hazards that affects the agricultural workers most was done. The incidence of musculoskeletal problems, Body Part Discomfort Score (BPDS) and total body discomfort was obtained using 'Body Map' technique developed by Corlett and Bishop (1976). The discomfort perceived by the respondents was also rated on a Visual Analogue Discomfort (VAD) Scale and thus Overall Discomfort Rating (ODR) was obtained.

### **Results:**

The Mean Percent Scores (MPS) of the respondents for physiological hazard reveal that approximately 60 per cent of males experienced it during sowing, plant protection, harvesting and threshing whereas nearly 70 per cent of females reported this hazard during sowing, harvesting, weeding and threshing activity. For mechanical hazards the MPS proved that in weeding 93 per cent of females and 83 per cent of male farm workers were affected. During plant protection and sowing 43 percent and 35 percent of males respectively reported this hazard. The MPS of the female respondents for environmental hazards during weeding was 59 percent. Regarding occurrence of musculoskeletal problems results showed that 80-85 percent of the respondents stated very severe to severe pain in low back while performing agricultural activities. For female respondents the highest BPDS was for weeding activity whereas for males highest BPDS was for land preparation activity. The ODR scores revealed that weeding was the most strenuous activity for females and threshing crops for male respondents. Educational intervention on hazards and safety in agriculture work improved the knowledge of the agricultural workers improved on exposure which proves that risks of many health hazards and musculoskeletal problems can be minimized through education and training.

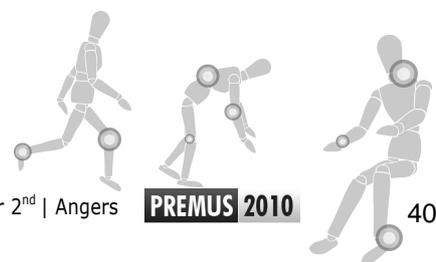
### **Conclusion:**

Thus, to conclude it can be said that agriculture poses many health hazards and musculoskeletal problems to the workers. Training and education can bring awareness of hazards and safety in agriculture work and can be effective of mitigating occupational health hazards and musculoskeletal problems in agriculture.

**Keywords:** Agriculture, Surveillance, Intervention methods

### **References:**

- Corlett E.N., Bishop R. P. (1976). A technique for assessing postural discomfort. *Ergonomics*. 19:175-182.  
Meeker B. J., Carruth A, Holland C. B. (2002). Health hazards and preventive measures of farm women. *Emerging issues. AAOHN J.* 50 (7): 307-14.  
Nag P. K., Nag A. (2004). Drudgery, accidents and injuries in Indian agriculture. *Industrial Health*, 42(2): 149-62.



## MEASURING EFFECTS OF INTERVENTIONS

### EXPLICIT AND IMPLICIT CHANGE THEORIES BEHIND ERGONOMIC INTERVENTIONS IN WORKING LIFE; A SYSTEMATIC REVIEW

WIJK K., MATHIASSEN S.E.

*Centre for Musculoskeletal Research, University of Gävle, Sweden*

#### **Aims:**

Ergonomics interventions are planned and implemented in occupational settings for the purpose of preventing musculoskeletal disorders. Any intervention will be preceded by a planning phase when designing a strategy for the intended change, and the intervention will, at least to some extent, be implemented in accordance with that strategy. The strategy, in turn, reveals explicit or implicit assumptions about the intended process of change associated with the intervention. The purpose of this systematic review was to explore if, and if so how, theories on change processes have been used in the strategic planning or implementation of ergonomic interventions reported in literature.

#### **Methods:**

A systematic search, inspired by the Cochrane collaboration, was conducted in 13 reference databases; containing a total of approximately 15000 journals. Keywords were identified in titles, abstracts and aims. Articles included were published between 2000 and 2007. Thirty studies were included in the review, and explicit and implicit theories of change were identified.

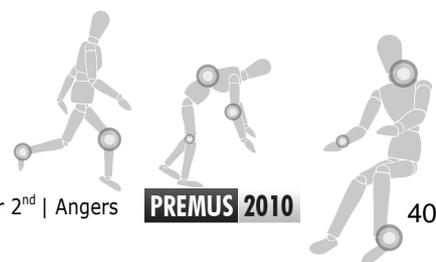
#### **Results:**

A model categorising the theoretical positions of each intervention was used to illustrate to which extent authors argue for pedagogical ideas conveyed in the texts. Twenty-five studies showed to adhere to a deeply rooted strategy whereas five revealed weakly rooted arguments for the intervention strategy. Four categories of intervention strategies were identified. The first was "strategies targeting the individual". These strategies implicitly assume that the individual will develop a healthy behaviour at work if she possesses sufficient knowledge and is trained in appropriate techniques or skills. Another category was "strategies focusing on the environment", inferring that since the external environment affects the body, workplace health can improve by changing the environment. Thirdly, "changes caused by people interacting" refers to processes in which people at work are influenced or inspired by colleagues through, e.g. communicative activities. The fourth category is "structural- and organisational strategies", assuming that policies and organisational structures contribute to change and that key persons participating in, e.g. boards or committees promote workplace health. Thirteen of the 30 studies referred to an explicit theory of change, the most common was participatory theory.

#### **Conclusion:**

Awareness of implicit or explicit assumptions about change processes in intervention strategies may help to identify, make visible and reflect upon the ideas and processes that promote or restrict successful implementation of interventions. Such considerations, in turn, can contribute to a better design of more enlightened intervention strategies, on the basis of the desired outcomes.

**Keywords:** Intervention studies, Intervention methods, Disability prevention



## METHODS TO EVALUATE THE EFFECTIVENESS OF PHYSICAL ACTIVITY PROMOTION MEASURES AT SEDENTARY WORKPLACES

WEBER B., MAHLBERG R., ELLEGAST R.P.

*Institute for Occupational Health and Safety of the German Social Accident Insurance (IFA), Sankt Augustin, Germany*

### Aims:

Physical inactivity and prolonged static work tasks may seriously affect the cardiovascular and the musculoskeletal system [1]. These health risks can be reduced by preventive strategies which promote physical activity (PA) at sedentary workplaces. To evaluate the effectiveness of promoting measures adequate methods to identify differences in PA behaviour are essential. For this purpose, we tested the suitability of different measurement methods in an intervention study.

### Methods:

To test the methods' suitability, measurable differences in PA were required. Therefore, a randomised controlled trial (n=25) at office workplaces was conducted. To make an increase of PA for the intervention group (n=13) most likely, a comprehensive package of measures was implemented. The package consisted of measures aiming at the working conditions (e.g. height-adjustable desks) and the behaviour (e.g. pedometers, face-to-face motivation). The intervention lasted 12 weeks. During this time, occupational PA was assessed by activity logs and commercial activity sensors (AiperMotion). Precise assessments before and during the intervention were undertaken with a self-developed measurement system (CUELA Activity System) [2]. Operating with multiple movement sensors, this system automatically identifies various activities and body postures, determines energy expenditure and PAI levels (Physical Activity Intensity) of different body regions.

### Results:

The activity logs showed that, compared to the control group, subjects of the intervention group spent more time standing and less time sitting during the whole period ( $p \leq 0.001$ ). AiperMotion found higher step numbers for the intervention group ( $p \leq 0.001$ ). CUELA analyses revealed significant differences in behaviour change: Whereas no change was found for the control group, a reduction of sitting ( $p \leq 0.001$ ) and an increase of standing ( $p \leq 0.001$ ) and walking ( $p \leq 0.01$ ) as well as increased PAI levels of the upper and lower extremities and the trunk (each  $p \leq 0.001$ ) were detected.

### Conclusion:

Due to the described group and pre/post differences, it can be concluded that the intervention was effective. The sensitivity of the different measurement methods turned out to be adequate for use in an intervention study. The AiperMotion reports the time spent actively and number of steps, but can not discriminate between sitting and standing. The activity logs provide the time spent sitting, standing and moving which, however, is based on subjective estimations. By means of CUELA considerably more differentiated and objective data is available. Hence, CUELA is a valuable tool to supplement simple instruments and prove self-reported data. Altogether, the combined use of intervention-accompanying methods and a selectively applied complex technique seems promising for future analyses of intervention effects.

**Keywords:** Postures, physical exposure, Exposure measurement methods, Intervention studies

### References:

Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C et al. Physical activity and health. A recommendation from the Centers for Disease Control and Prevention and the American College for Sports Medicine. *JAMA*. 1995; 273:402-7

Weber B, Hermanns I, Ellegast R, Kleinert J. A person-centered measurement system for quantification of physical activity and energy expenditure at workplaces. In: Karsh B-T, editor. *Ergonomics and Health Aspects, HCII 2009*. Berlin: Springer; 2009. p 121-130. LNCS 5624



## A RANDOMIZED CONTROLLED TRIAL OF A TAILORED MUSCULOSKELETAL DISORDER PREVENTION INTERVENTION – PRELIMINARY RESULTS

ROTHMORE P., PISANIELLO D., STEWART S., DODA D.

*The University of Adelaide, Adelaide, Australia*

### **Aims:**

Despite numerous, multi-faceted intervention strategies musculoskeletal disorders remain the largest, and most costly, category of injury in the workplace. Clearly, there is an ongoing need to improve our understanding of the factors associated with musculoskeletal disorders and the design and implementation of injury prevention initiatives.

The aim of this research is to evaluate the efficacy of a behavior-based intervention in a cohort of companies from a wide range of industries in a randomized control trial. This paper describes the study methodology, survey methods and preliminary results.

### **Methods:**

A cohort of 24 companies and 406 workers (representing workgroups of between 12 and 20 employees) from a wide range of industries were recruited and surveyed. Data on worker demographics, musculoskeletal pain and discomfort, job satisfaction and safety climate were collected using previously published survey instruments. Preparedness and awareness of the need for safety-related behavior change was assessed using a psychological assessment tool. Participating companies were randomly allocated to either the control or intervention arm and each was inspected by an ergonomist who undertook direct observation of work practices prior to preparing a written report for the company detailing suggestions for improvement. For companies in the intervention arm of the study the recommendations were tailored according to the results of the psychological assessment of worker's behavior. Collection of baseline data will be repeated 12-months after receipt of recommendations.

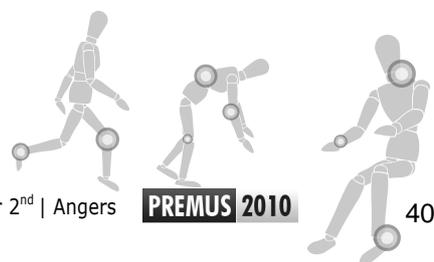
### **Results**

Preliminary results suggest that workers in Australia are at a higher level of awareness and experience less pain and discomfort compared with UK findings. Older workers, and those with greater length of employment, were found to be more "risk-aware". While baseline survey instruments will be formally repeated 12-months post-intervention (this is currently underway) early results indicate there is high variability in the implementation of initiatives to date but that those companies in receipt of tailored advice have been able to prioritize their improvements with greater focus and economy.

### **Conclusion:**

Evaluation of the effectiveness of injury prevention initiatives in the workplace is rarely undertaken by professional consultants. Similarly, randomized control trials involving multiple organizations pose significant logistic and organizational hurdles. This cohort and the early data analysis undertaken indicate that while organizations are variable in their implementation of professional advice, more precise tailoring of such recommendations according to a psychological assessment of predicted behavior may be beneficial.

**Keywords:** Psychosocial factors, Intervention studies, Intervention methods



## WORKPLACE INTERVENTIONS FOR NECK PAIN IN WORKERS. A SYSTEMATIC REVIEW

AAS R.W., TUNTLAND H., HOLTE K.A., RØE C., LUND T., MARKLUND S., MOLLER A., LABRIOLA M., SKAUGEN B.H.

*PreSenter, International Research Institute of Stavanger, IRIS, Norway*

### Aims:

Musculoskeletal disorders are the most common causes of long term sick leave and disability pension in many industrial countries. Recurrent and chronic pain accounts for a substantial portion of the workers absenteeism. Neck and shoulder pain seems to be more prominent in the general population than previously known. Neck pain is a common phenomenon, also in workers where the annual prevalence of neck pain in workers varies from 27.1% to 47.8% in investigated studies. The aims of this systematic review was to determine the effectiveness of workplace interventions in working age adults with neck pain.

### Methods:

We searched the following databases until July 2009 without any language limitations: CENTRAL (The Cochrane Library), MEDLINE, EMBASE, CINAHL, PsycINFO, ISI Web of Science, OTseeker, PEDro (to July 2009). In addition, we screened reference lists and contacted experts in the field. Only randomised controlled trials that assessed adult workers with neck pain were included. Each study was analysed by two researchers independently according to Cochrane instructions. After having analysed the studies, the two researchers compared their results. In the few cases where differences occurred, discussions led to agreement. Authors were contacted for missing information.

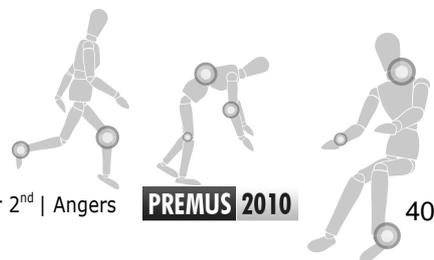
### Results:

Nine trials, with a total of 2553 participants were included. Two studies were rated as having low risk of bias. The large variations in the content of interventions and outcomes measurements restricted pooling of data across studies. Only one metaanalyses could be performed, showing that there was low quality of evidence that ergonomic counselling versus no intervention reduces pain at 12 months follow-up. The studies regarding the interventions workplace modifications and ergonomic counselling had in general marginal or no effect with few significant exceptions which was not confirmed at other follow-ups, and the results varied among outcomes. In general, current RCTs did not reveal sustainable evidence to support that any specific workplace intervention or combination of workplace interventions is likely to reduce neck pain or sick leave.

### Conclusion:

No sustainable or no effects of workplace interventions were found regarding neck pain and sick leave. Hence, there is an urgent need for randomised controlled trials tailored towards neck pain with well designed interventions targeting also the psychosocial causes for neck pain.

**Keywords:** Computer work, psychosocial factors, intervention studies



## PARTICIPATORY ERGONOMICS: EVIDENCE ON EFFECTIVENESS AND IMPLEMENTATION

VAN EERD D.<sup>1,2</sup>, COLE D.<sup>1,3</sup>, KEOWN K.<sup>1</sup>, IRVIN E.L.<sup>1</sup>

<sup>1</sup> Institute for Work & Health, Toronto, Canada – <sup>2</sup> Applied Health Sciences, University of Waterloo, Canada – <sup>3</sup> Dalla Lana School of Public Health, University of Toronto, Canada

### Aims:

Participatory ergonomics (PE) is an effective approach to improving worker health (1,2). This presentation will cover evidence from the literature on effectiveness and implementation of participatory ergonomics (PE) interventions from systematic reviews of literature. An evidence-based tool (pamphlet) on how to initiate PE will also be presented.

### Methods:

Two systematic reviews were done with teams of researchers and ergonomists, and input from Occupational Health and Safety stakeholders. The review process involved six steps: developing the review question, creating and completing a literature search, assessing relevance (inclusion/exclusion), assessing quality, data extraction, and synthesis. The review on PE effectiveness focused on peer-reviewed literature which reported on evaluating PE on worker health outcomes. The methodological quality criteria were stringent. Data extraction and best evidence synthesis revealed three outcomes of interest: Lost days/sickness absence, worker compensation costs, symptoms/disorders. The review on PE process included both peer-reviewed and grey literature. Documents describing a PE intervention were relevant, and quality criteria were adapted to non-scientific documents. Data was synthesized according to most often reported process and implementation approaches. An evidence-based tool was developed by review team members with stakeholder input.

### Results:

The effectiveness review search yielded 442 articles, 23 were deemed relevant and of those 12 met minimal quality. Using a best evidence synthesis approach we found limited evidence that PE can reduce lost days/sickness absence and MSD injuries/compensation claims and moderate evidence that PE can reduce MSD symptoms. The process and implementation review search yielded 2151 documents, 190 were deemed relevant and 52 met content/quality criteria. Different ergonomic teams were described as were the type, duration and content of ergonomic training. Team responsibilities included problem identification, solution design and implementation. Decisions were generally made using group consultation. PE interventions tended to be ongoing, have worker representation, focus on physical changes and report positive impacts. Resources, program support, ergonomic training, organizational training and communication were the most often noted facilitators/barriers. A tool (pamphlet) was developed incorporating research evidence.

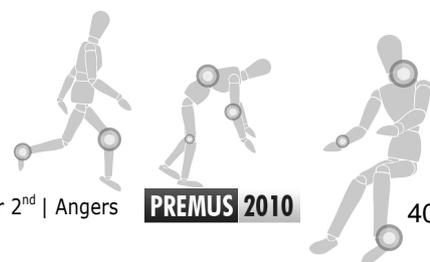
### Conclusion:

Research evidence suggests PE can be effective in improving worker health. However more high quality research is needed. PE interventions require the right people to be involved with appropriate training and clear responsibilities. Addressing key facilitators and barriers such as program support, resources, and communication is paramount (3). A newly developed tool may help practitioners initiate and sustain PE interventions in workplaces.

**Keywords:** Methods in epidemiology, intervention studies, intervention methods

### References:

- Hignett, S., Wilson, J.R., and Morris, W., 2005, Finding ergonomic solutions—participatory approaches. *Occupational Medicine*, 55, pp. 200-207., 2)
- Rivilis I, Van Eerd D, Cullen K, Cole DC, Irvin E, Tyson J, Mahood Q. Effectiveness of participatory ergonomic interventions: a systematic review. *Applied Ergonomics* 2008; 39: 342-358., 3)
- Van Eerd D, Village J, Clarke J, Cole D, Cullen K, Irvin E, Keown K, Mahood Q, St-Vincent M, Theberge N. Participatory ergonomics interventions: implementation and process, a systematic review. Toronto: Institute for Work & Health; December 2007.



## ECONOMIC ASPECTS

### WORKPLACE ERGONOMIC INTERVENTIONS WITH ECONOMIC ANALYSES: A SYSTEMATIC REVIEW

IRVIN E.L., TOMPA E., DOLINSCHI R., DE OLIVEIRA C., AMICK B.C.

*Institute for Work & Health, Toronto, Canada*

#### **Aims:**

This presentation reports on a systematic review of workplace ergonomic interventions with economic evaluations. The review sought to answer the question: “what is the credible evidence that incremental investment in an ergonomic interventions is worth undertaking?” Past efforts to synthesize evidence from this literature have focused on effectiveness, whereas this study synthesizes evidence on the cost-effectiveness/financial merits of such interventions.

#### **Methods:**

This review is a sub-set of a systematic review that included all types of OHS interventions. In an attempt to be thorough the review team undertook the following: conducted a structured bibliographic database search of 5 electronic databases, a review of other systematic reviews underway or completed, circulated a request for studies identified by content experts, and performed a search of bibliographies of included studies. A qualitative synthesis approach, known as best evidence synthesis, was used rather than a quantitative approach because of the diversity of study designs and statistical analyses found across studies. Evidence on the financial merits of interventions was synthesized by industrial sector.

#### **Results:**

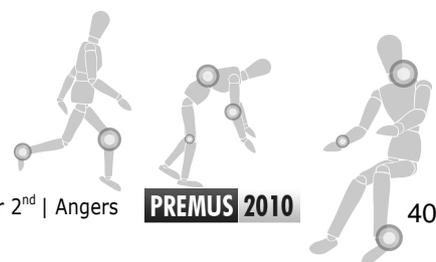
35 ergonomic intervention studies were identified in nine industrial sectors. In the manufacturing and warehousing sector strong evidence was found in support of the financial merits of ergonomic interventions from a firm perspective. In the administrative support and health care sectors moderate evidence was found, in the transportation sector limited evidence, and in remaining sectors insufficient evidence.

#### **Conclusion:**

The review highlights the need for a more systematic consideration of the financial merits of ergonomic interventions and a further development of standardized analytic methods in order to ensure a larger and more reliable evidence base on the financial merits of such interventions.

Most ergonomic intervention studies focus on effectiveness. Few consider their financial merits. Amongst the few that do, several had exemplary economic analyses, although more than half of the studies had low quality economic analyses. This may be due to the low priority given to the economic analysis part of the overall evaluation of many studies. Often only a small part of the overall evaluation of many studies focused on evaluating their cost-effectiveness.

**Keywords:** Postures, Physical exposure, Intervention studies, Economics



## ECONOMIC EVALUATIONS OF OCCUPATIONAL HEALTH INTERVENTIONS FROM A COMPANY'S PERSPECTIVE: A SYSTEMATIC REVIEW OF METHODS TO ESTIMATE THE COST OF HEALTH-RELATED PRODUCTIVITY LOSS

UEGAKI K., DE BRUIJNE M.C., VAN DER BEEK A.J., VAN MECHELEN W., VAN TULDER M.

*EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands*

### Aims:

In economic evaluations conducted from a company's perspective, the benefit of occupational health interventions is commonly expressed in terms of changes in health-related productivity, which are translated into a monetary value [1]. Methods use to measure and value this key outcome can vary widely, hindering the comparability of studies [2]. The aim of this systematic review was to investigate the extent of variability in the methods used to measure and value changes in health-related productivity in economic evaluations from a company's perspective and provide suggestions for improvement.

### Methods:

The primary literature search was conducted in Medline and Embase. Supplemental searches were conducted in the Cochrane NHS Economic Evaluation Database, the National Institute for Occupational Safety and Health database, the Ryerson International Labour, Occupational Safety and Health Index database, scans of reference lists and researcher's own literature database. Article selection was conducted independently by two researchers based on title, keywords, and abstract, and if needed, full text. Differences were resolved by a consensus procedure. Articles were selected based on seven criteria addressing study population, type of intervention, comparative intervention, outcome, costs, language and perspective, respectively. Characteristics of the measurement and valuation of health-related productivity changes were extracted and analyzed descriptively.

### Results:

A total of 34 studies were included. Changes in health-related productivity were estimated using (a combination of) data related to sick leave, compensated sick leave, light or modified duty or work presenteeism. Data were collected from different sources (e.g. administrative databases, worker self-report, supervisors) and by different methods (e.g. questionnaires, interviews). Valuation varied in terms of reported time units, composition and source of the corresponding price weights, and whether additional elements, such as replacement costs, were included.

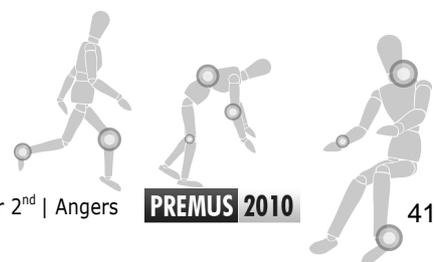
### Conclusion:

Methods for measuring and valuing changes in health-related productivity vary widely, hindering comparability of results and decision-making. Five suggestions for improvement include: 1. use of standardized questionnaires; 2. explicit presentation of measurement methods and time units in a disaggregate form; 3. explicit presentation of the composition and source of price weights used for valuation purposes; 4. explicit presentation of additional effects included in the analysis as well as the rationale for this including these effects; and 5. clear description of the socio-political context and distribution of burden in which the study takes place.

**Keywords:** Intervention studies, Return to work, Economics

### References:

Greenberg PE, Birnbaum HG, Kessler RC, Morgan M, Stang P. Impact of illness and its treatment on workplace costs: regulatory and measurement issues. *J Occup Environ Med* 2001 Jan;43(1):56-63.  
Adam T, Koopmanschap MA, Evans DB. Cost-effectiveness analysis: can we reduce variability in costing methods? *Int J Technol Assess Health Care* 2003;19(2):407-20.



## ECONOMIC EVALUATION OF AN INTERVENTION PROGRAM ON EXPOSURE TO RISK FACTORS, PREVALENCE OF ARM, SHOULDER AND NECK SYMPTOMS, AND SICK LEAVE IN COMPUTER WORKERS

SPEKLÉ E.M.<sup>1,2,3</sup>, HEINRICH J.<sup>2,5</sup>, HOOZEMANS M.J.M.<sup>1,2</sup>, BLATTER B.M.<sup>2,5</sup>, VAN DER BEEK A.J.<sup>2,4</sup>, VAN DIEËN J.H.<sup>1,2</sup>, VAN TULDER M.<sup>6</sup>

<sup>1</sup> Research institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands - <sup>2</sup> Body@Work, Research Centre on Physical Activity, Work and Health, The Netherlands - <sup>3</sup> Arbo Unie, Haarlem, The Netherlands - <sup>4</sup> Department of Public and Occupational Health, EMGO Institute for Health and Care Research, VU University Medical Centre, Amsterdam, The Netherlands - <sup>5</sup> TNO Quality of Life, Hoofddorp, The Netherlands - <sup>6</sup> Section Health Economics & Health Technology Assessment, Faculty of Earth and Life Sciences, VU University, Amsterdam, The Netherlands

### Aims:

The purpose of this study was to perform an economic evaluation of the RSI QuickScan intervention programme for computer workers. In this study, effectiveness was defined at three levels: exposure to risk factors, prevalence of arm, shoulder and neck symptoms, and days of sick leave.

### Methods:

The economic evaluation was conducted alongside a randomised controlled trial (RCT). Participating computer workers from 7 companies (N=638) were assigned to either the intervention group (N=320) or the usual care group (N=318) by means of cluster randomisation (N=50). The intervention consisted of a tailor-made programme, based on a previously established risk profile. At baseline, 6 and 12 month follow-up, the participants completed the RSI QuickScan questionnaire.

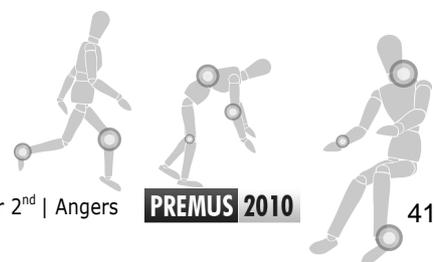
### Results:

The mean intervention costs, paid by the employer, were €59 per participant in the intervention and €28 in the usual care group. Mean total health care and non-health care costs per participant were €108 in both groups. As to the cost-effectiveness, improvement in received information on healthy computer use as well as in their work posture and movement was observed at higher costs. With regard to the other risk factors, symptoms and sick leave, only small and non-significant effects were found.

### Conclusion:

In this study, the RSI QuickScan intervention programme did not prove to be cost-effective and, therefore, this study does not provide a financial reason for implementing this intervention. However, with a relatively small investment, the programme did increase the number of workers who received information on healthy computer use and improved their work posture and movement.

**Keywords:** Computer work, Intervention studies, Economics.



## DIRECT WORKERS' COMPENSATION COSTS FOR PATIENT HANDLING INJURIES SURROUNDING A HOSPITAL-WIDE POLICY CHANGE TO MINIMAL MANUAL LIFTING OF PATIENTS

LIPSCOMB H.J., SCHOENFISCH A.L., MYERS D.J., POMPEII L.A., DEMENT J.M.

*Duke University Medical Center, Durham, North Carolina. USA; University of Texas School of Public Health, Houston, Texas, USA*

### Aims:

Workers' compensation costs provide insight into injury severity as well as economic burden, not discernible in injury-rate data alone, thus providing an additional measure to use in assessing effects of safety interventions. We evaluated costs for patient-handling injuries of a musculoskeletal (MS) nature in a large tertiary care hospital and an affiliated community hospital in the 11 years surrounding an institution-wide shift to a 'minimal manual patient-lifting environment' (MMLE) supported with mechanical lift equipment on inpatient units.

### Methods:

Mean and median adjusted and discounted costs (payments) per claim were calculated for each hospital by year (1997-2007) and by job. Negative binomial regression was used to model payments and adjusted payment ratios as well as payment rates based on fulltime equivalents (FTEs). Risk of higher cost was assessed based on job, age, gender, institutional tenure, and calendar time since the policy change (2004). Lagging was used to evaluate latency of effect with comparison of effects on staff with and without access to lift equipment. A series of models stratified by job, hospital, type of injury and calendar time were used to clarify observed effects.

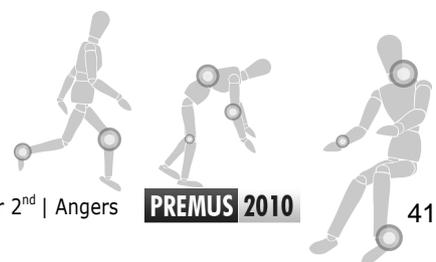
### Results:

Over the 11-year period, patient handling injuries (n=1260) were responsible for 73% of MS injuries among patient care staff and 68% of compensation costs. Mean costs per claim were over 5 times higher for those over age 45 than those < 25; costs also varied by job, age, hospital and calendar time. There was an immediate, marked decline in mean costs. Costs of pt handling injuries were 3.5 times (95% CI 2.1-6.0) higher before the policy change than after; costs of other MSDs were 1.6 (0.37-6.5) higher. The early changes affected patient transporters, radiology staff, therapists, and nursing staff who did not have immediate access to lift equipment. Cost rates, reflecting changes in mean costs as well as changes in reported injury frequency, were similarly affected.

### Conclusion:

While marked declines in costs were observed following the policy change, the pattern of cost change likely reflects effects of activities other than use of lift equipment including targeted efforts to close WC claims and an almost simultaneous policy that shifted cost responsibility to the budgets of managers on individual units instead of the institution. Rather than identifying a 'best mathematical model,' the most enlightening information came from examination of multiple stratified models.

**Keywords:** Health care workers, Epidemiology, Intervention studies.



## AN ECONOMIC JUSTIFICATION FOR THE IMPLEMENTATION OF INTERVENTIONS THAT REDUCE KNEE INJURIES IN UNDERGROUND MINING

MOORE S.M., POLLARD J.P.

*National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA*

### **Aims:**

The 2007 United States Mine Safety and Health Administration database reported 227 knee injuries occurring in underground coal. From workers' compensation data, the National Institute for Occupational Safety and Health (NIOSH) determined that the average cost per knee injury in this industry was \$13,121.29 yielding nearly three million dollars as an estimated financial burden of these injuries on the industry in 2007. Recently, NIOSH has investigated various types of interventions that underground coal mining companies may implement as means for decreasing mine workers' risk for developing knee injuries. These interventions include a training program that instructs mine workers how to identify symptoms of knee injuries and seek medical attention, redesign their work areas to reduce twisting on the knees, routinely move their knee joints through their full range of motion when kneeling or squatting for extended periods of time, maintain good hygiene of clothing and kneepads to reduce injuries due to infected hair follicles, and implement at-home strengthening and stretching regimens for the leg muscles. To encourage mining companies to implement this training program and interventions currently in development, NIOSH performed an analysis of workers' compensation data for one underground coal mine in Illinois and six in Pennsylvania.

### **Methods:**

The data were for the 2004, 2005, and 2006 claim years of each mine and included medical and indemnity costs for injuries to each body part, the number of injuries per body part, and the annual audited payroll. The rating formulas for the respective states were utilized to determine workers' compensation premiums for 2008 which require injury data from 2004 to 2006. For each mine, the cost of workers' compensation premiums were determined for all the injuries reported. A second analysis was then performed whereby all knee injuries were excluded.

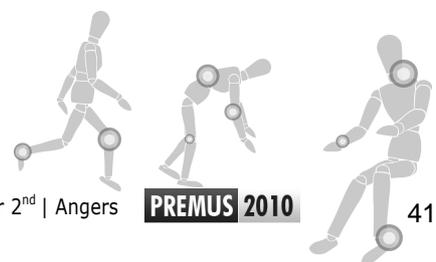
### **Results:**

By eliminating knee injuries, the annual workers' compensations premiums decreased by 1.1% to 9.3%. This translated to a savings of \$4,206 to \$1,379,876.

### **Conclusion:**

The cost of implementing the NIOSH training program is minimal as mines are required to provide annual safety training whereby the NIOSH training program could easily be provided to the mine workers. Moreover, based on experimental data NIOSH collected during kneeling and crawling tasks, NIOSH is currently developing a kneepad for miners that are restricted to their knees. This kneepad will better distribute the forces applied to the knee decreasing the stress experienced at the knee and reducing injury risk.

**Keywords:** Specific sectors, Intervention studies, Economics.



## MUSCULOSKELETAL DISORDERS COMPENSATION COSTS AS A FUNCTION OF AGE AND INDUSTRY

DAVIS K.G., DUNNING K.K., KOTOWSKI S.E., HAMRICK C., LOCKEY J.

Departments of Environmental Health and Rehabilitation Sciences, University of Cincinnati, Cincinnati, Ohio, ESIS, Inc. – Global Risk Control Services, Westerville, Ohio, USA

### Aims:

By 2010, a major shift in the age distribution will occur in the workforce, which will result from the majority of the baby boomers becoming 65 years or older with 80% of them planning to work after retirement age (Rix, 2004). Previous research has indicated that older workers suffer from more severe injuries with longer recovery times, which may result in greater compensation costs (Burton and Spieler, 2001). The aim of the study was to determine the age-related compensation costs for different types of musculoskeletal disorders.

### Methods:

A total of 572,508 MSD claims submitted to the Ohio Bureau of Workers' Compensation between 1999 to 2004 were analyzed for total costs (e.g. medical and indemnity) as function of age group (16 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years, and 65+ years), MSD diagnosis (based on ICD-9 codes), and industry sector (manufacturing, construction; transportation, warehouse, and utilities (TWU), wholesale and retail trade (WRT), service, and health and social assistance).

### Results:

The majority of the claims occurred between the ages of 25 and 54, accounting for more than 75% of the claims. While the overall trends for MSDs were bell-shaped (e.g. lower at young ages, peaked in middle age groups and declined for older), not all body regions resulted in declines for costs in the older groups. Costs for shoulder claims remained elevated in the older age groups, particularly in the TWU industry. Low back and shoulder MSDs place the greatest burden on the Workers' Compensation system, particularly in the later years where average costs exceed \$15,000 per claim.

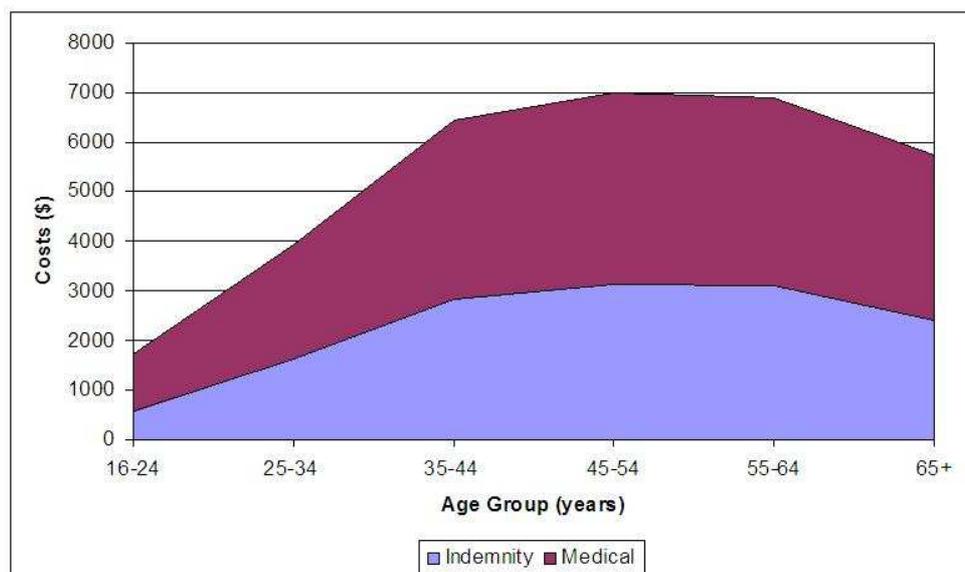


Figure: Average Costs Per MSD Claim as a Function of Age Group

### Conclusion:

The results of the study points toward both age and industry specific exposures as contributing factors for the financial burden of MSDs.

**Keywords:** Specific sectors, Economics, Older workers

### References:

Rix SE, AARP Public Policy Institute, 2004; [www.aarp.org/ppi](http://www.aarp.org/ppi)

Burton, JF, Spieler, E, Workers' compensation and older workers, National Academy of Social Insurance 2001; 3.



## WORK ABILITY, PHYSICAL FITNESS

### WHAT EXPLAINS RETURN TO WORK AND WORK ABILITY- AN ANALYSIS OF EXPECTATIONS, HEALTH AND DISABILITY VARIABLES

ÖBERG B., BENRFORT L., WÅHLIN NORGREN L., PERSSON J., EKBERG K.

*Department of Medical and Health Sciences, Linköping University, Sweden*

#### **Aims:**

It has been shown that return to work to a large extent is dependent on cognitive factors and not only physical factors. Patients own expectations and beliefs on recovery, workability and intention to return to work are important predictors of return to work. Patients often return to work before they are fully recovered in terms of their self rated work ability

The aim of this study was to analyze how expectations of recovery, expectations of return to work, and symptom satisfaction are related to perceived work ability and return to work in a cohort of patients with musculoskeletal (MSD) and mental disorders(MD) on recent sick leave.

#### **Methods:**

In a prospective cohort study all individuals on recent sick leave, who sought primary care or occupational health service for musculoskeletal disorders (MSD) and/or mental disorders (MD) were included. Data collection was based on a baseline questionnaire including demographic variables, Functional rating index (FRI), health (EQ 5D), work ability and expectations on recovery, return to work and symptom satisfaction. A three months' follow up questionnaire included self perceived work ability and information on present working status.

#### **Results:**

The preliminary results are based on 352 patients, 2/3 women and 1/3 men. 38% had MD and 62% had MSD. About two thirds of the patients had returned to work after 3 months.

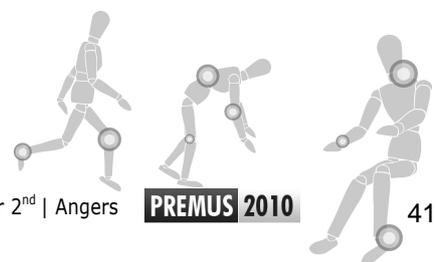
There was no difference in level of expectations between men and women nor between MSDs or MDs.

Expectations to return to work and self rated disability level at baseline explained being at work after 3 months, while expectations to return to work, health( EQ 5D) and self rated disability level ( FRI) explained self reported work ability at 3 months. Change in work ability was explained by expectation to return to work and symptom satisfaction but with low explanatory value. Gender or diagnosis did not explain return to work nor work ability.

#### **Conclusion:**

The strongest explanatory variable in this cohort of patients at recent sick leave for both work ability and return to work was expectations to return to work. Expectations on recovery and symptom satisfaction did not have any explanatory value. As expected, the health and disability variables also contributed to explained work ability. There is a difference in which variables that explains return to work and work ability with more explanatory value for return to work in cognitive variables

**Keywords:** Early prevention, Return to work, Specific health outcomes



## RELEVANCE OF NORMATIVE VALUES FOR FUNCTIONAL CAPACITY EVALUATION

SOER R., VAN DER SCHANS C.P., GEERTZEN J.H.B., BROUWER S., DIJKSTRA P.U., RENEMAN M.F.

*Center for Rehabilitation, University Medical Center Groningen; Graduate School for Health Research, University of Groningen, The Netherlands.*

### Aims:

To establish normative values for Functional Capacity Evaluation (FCE) corrected for workload in order to narrow the gap between work load and work capacity and to discuss relevance for normative values.

### Methods:

Included were healthy subjects who were:

- healthy and working > 20 hrs per week,
- between 20 and 60 yrs of age,
- reported sick leave less than 5% in the previous year,
- not suffering from co-morbidity.

Subjects performed an FCE consisting from 12 subtests; lifting low, lifting high, carrying, repetitive reaching, dynamic bending, overhead working, forward bending, Purdue Pegboard task, Complete Minnesota Dexterity test, hand and finger strength, aerobic capacity.

Subjects were categorized based on their work demands as defined by the Dictionary of Occupational Titles.

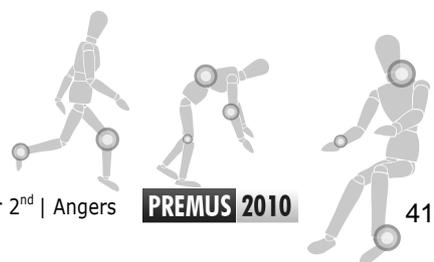
### Results:

Normative FCE values of 701 healthy working subjects (448 male, 253 female), working in over 180 professions, were established for 4 physical demand categories (sedentary, light, medium, heavy/very heavy work).

### Conclusion:

Normative values enable comparison of patients' performances to these values. If a patient's performance exceeds the lowest scores in his/her corresponding demand category, then the patient's capacity is very likely to be sufficient to meet the workload. Further, clinicians can make more precise return to work recommendations and set goals for rehabilitation programs. A comparison of the normative values can be useful to the fields of rehabilitation, occupational and insurance medicine. Further research is needed to test validity of the normative values with respect to work place assessments and return to work recommendations.

**Keywords:** Exposure measurement methods, Return to work, Pain, chronic pain



## PREDICTIVE VALIDITY OF SELF-REPORTED WORK ABILITY AND FUNCTIONAL CAPACITY EVALUATION LIFTING TESTS ON DURABLE RETURN TO WORK IN CONSTRUCTION WORKERS

KUIJER P.P.F.M., GOUTTEBARGE V., WIND H., SLUITER J.K., FRINGS-DRESEN M.H.W.

Academic Medical Center, University of Amsterdam, Department: Coronel Institute of Occupational Health, Amsterdam, The Netherlands

### Aims:

A recent study suggests that Functional Capacity Evaluation (FCE) lifting tests in combination with self-reports might have an added value for decision making regarding return to work (RTW) (Gouttebarge et al. 2009). The aim of the present study is to test whether a self-report in combination with FCE is a better predictor for durable RTW than a self-report only.

### Methods:

A longitudinal within-subject design with a one-year follow-up period was conducted among 68 construction workers performing heavy physical work and on sick leave for at least 6 weeks due to musculoskeletal disorders.

Six weeks after the first sick leave day, construction workers performed three Ergo-Kit Functional Capacity Evaluation (EK FCE) lifting tests: Lower Lifting Strength test (lifting from hip to below knee level), Upper Lifting Strength Test (lifting from hip to above shoulder level) and Carrying Lifting Strength Test (lifting from hip level and carrying the load for 5 m).

The current work ability of a construction worker compared with his lifetime best was self-reported on a scale from 0 to 10 using the first question ('current work ability compared with lifetime best') of the Work Ability Index. Time to durable RTW was defined as the duration of work absenteeism due to MSDs in calendar days from 6 weeks after the first day on sick leave until the first day of returning fully to the worker's own work or other work for a period of at least 4 weeks throughout the 1-year follow-up period.

Stepwise linear regression analyses was performed to test whether the explained variance regarding durable RTW significantly increased for a combination between self-reported work ability and one or more EK FCE lifting test.

### Results:

Two significant models were retrieved to predict durable RTW. The first model used work ability ( $R = 0.31$ , adjusted  $R^2 = 0.09$ ,  $F = 7.3$ ,  $df = 1$ ,  $p = 0.009$ ). The second model used work ability and the results of the FCE Lower Lifting Strength Test ( $R = 0.43$ , adjusted  $R^2 = 0.16$ ,  $F = 7.4$ ,  $df = 2$ ,  $p = 0.001$ ).

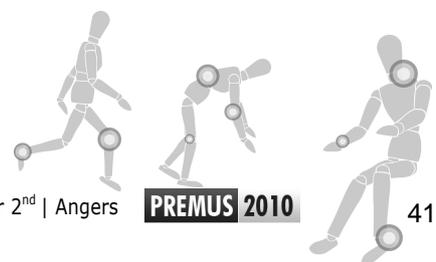
### Conclusion:

The combination of self-reported work ability and the result of the EK FCE Lower Lifting Strength Test increased the explained variance for durable RTW from 9% to 16%. Therefore, a combination of self-reports and performance based measures appear useful for return to work decisions.

**Keywords:** Construction, Disability prevention, Return to work

### Reference:

Gouttebarge V, Kuijer PPFM., Wind H, Sluiter JK, Frings-Dresen MHW. Criterion-related validity of Functional Capacity Evaluation lifting tests on future work disability and return to work in the construction industry, Occupational Environmental Medicine.



**TESTING PHYSICAL WORK ABILITY OF DUTCH FIRE FIGHTERS IN A JOB-SPECIFIC WAY**

PLAT M.J., FRINGS-DRESEN M.H.W., SLUITER J.K.

*Academic Medical Center, University of Amsterdam, Department: Coronel Institute of Occupational Health. P.O.Box 22700, 1100 DE Amsterdam, the Netherlands. Email: [m.j.plat@amc.nl](mailto:m.j.plat@amc.nl)***Aims:**

To test the physical work ability of fire fighters with two job-specific tests.

**Methods:**

Fire fighters (n=264) took two job-specific tests: the fire fighting simulation test and the fire fighting stair-climb test. Both are simulations of fire fighting activities and part of the new Workers' Health Surveillance for fire fighters in the Netherlands (1).

The fire fighting simulation test is a simulation of daily consecutive fire fighting activities. The test contained 12 parts that were successively executed, such as throwing and dragging hoses and rescuing a dummy. Afterwards fire fighters performed the fire fighting stair-climb test. An energetic peak load is tested by this test in a functional way. During the FFstair-climb, fire fighters climbed the stairs with their own turn out gear and SCBA. Fire fighters also carry fire fighting-related materials on their way up. During the tests testing time (in seconds) is recorded and for the stair-climb test heart frequency at the end of the test is recorded. The attained heart rate at the end of the fire fighting stair-climb was calculated as a percentage of the participants' estimated theoretically maximum heart rate (220 minus age (in years)).

**Results:**

Testing times for both tests are presented in table 1.

The mean value of the heart rate of the fire fighters immediately after performance of the fire fighting stair-climb compared to the estimated theoretically maximum heart rate was 95% (SD 7; range 69-116).

Table 1: The fire fighting simulation test and fire fighting stair-climb test: testing time in seconds mean, standard deviation (SD) and range (n=264)

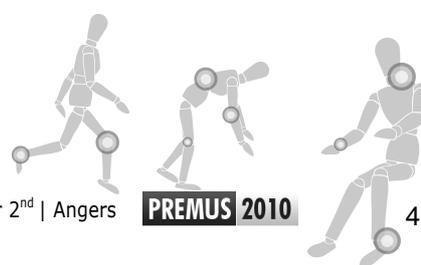
	Fire fighting simulation test		Fire fighting stair-climb test	
	Mean (SD)	Range	Mean (SD)	Range
Total group	935 (186)	648-1754	80 (27)	40-242
Male (n=223)	890 (136)	648-1345	73 (15)	40-155
Female (n=41)	1176 (229)	703-1754	120 (39)	71-242
Volunteer (n=125)	1014 (200)	667-1754	89 (33)	46-242
Professional (n=139)	867 (141)	648-1550	71 (15)	40-155

**Conclusion:**

Large variation in testing times for fire fighters in two job-specific tests has been found in general and in four worker groups specific: male, female, volunteer and professional. In the future, criteria to judge the fitness to perform the job by the job-specific tests will be further developed.

**Keywords:** Specific sectors, surveillance, specific health outcomes**Reference:**

1. Sluiter JK, Frings-Dresen MHW. Pre-employment and Periodical Workers' Health Surveillance in the Fire fighter sector. [In Dutch: Aanstellingskeuring en Periodiek Preventief Medisch Onderzoek (PPMO) voor de Brandweersector]. 2006. Amsterdam, Coronel Institute for Occupational and Environmental Health, Academic Medical Center.



## PHYSICAL FITNESS OF KOREAN WORKERS BY AGE, GENDER, AND JOB CHARACTER

KIM Y.H.<sup>1</sup>, YANG D.J.<sup>1</sup>, KANG D.M.<sup>2</sup>, KIM Y.K.<sup>2</sup>

<sup>1</sup> Korea occupational health & safety agency, Korea - <sup>2</sup> Pusan national university Yangsan hospital, Korea

### Aims:

To study differences of physical fitness by age and sex, and to study whether physical work affects on physical fitness or not.

### Methods:

We executed physical fitness test at 8 branches of Korea occupational health & safety agency (KOSHA) in 2006-2007 among 31,983 workers. Physical fitness test items were maximal O<sub>2</sub> consumption, grasping power, sit-up, sit-and-reach, Sargent jump height, and response time of stimuli. All physical fitness tests were measured by Helmas III with structured protocol. The contents of questionnaire included age, sex, smoke, alcohol, exercise, and job contents. Statistical analyses were conducted for frequency test, t-test, and logistic regression. Statistical significance level was 0.05, and SAS (v9.1) was used.

### Results:

Age range of study subjects were from 10s to 60s. Number of male workers was 25,718 (15,415 blue-collar workers), and it of female was 6,265 (3,713 blue-collar workers). Older workers had lower physically fitness. The means of maximal O<sub>2</sub> consumption, grasping power, and sit-and-reach in male blue-collar workers were higher than those of white-collars. But the mean of grasping power was the only one which was higher in female blue-collar workers than white-collars. When age, BMI, basal metabolic rate, and exercise were adjusted in logistic regression analysis, male blue-collar workers had higher maximal O<sub>2</sub> consumption, grasping power, and sit-and-reach than white-collar workers. white-collar workers had higher sit-up, Sargent jump, response time to stimuli. All results of female blue-collar were lower than white-collar.

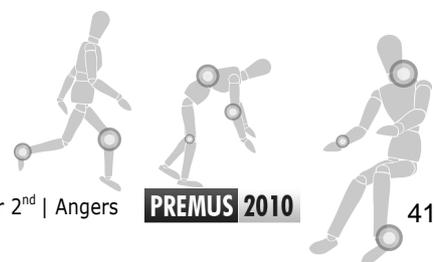
### Conclusion:

It was confirmed that the increase of age results in the decline of physical fitness. Then we found that physical fitness was influenced by physical work in different ways. Physical work affected on cardiopulmonary endurance and muscular strength, flexibility among male workers, but not for female workers. So these results say that the physical work intensity of work may affect on physical fitness.

**Keywords:** Economics, Older workers, Gender differences

### References:

Pohjonen T. Age-related physical fitness and the predictive values of fitness test for work ability in home care work. *J Occup Environ Med.* 2001;43:723-730.  
Gall, B., Parkhouse, W. Changes in physical capacity as a function of age in heavy manual work. *Ergon.* 2004;47:671-687.



## THE PROFILE FITNESS MAPPING QUESTIONNAIRE FOR THE NECK - RELIABILITY AND VALIDITY OF A NEW QUESTIONNAIRE FOR SYMPTOMS AND FUNCTIONAL LIMITATIONS IN SUBJECTS WITH NECK PAIN

BJÖRKLUND M., HAMBERG J., HEIDEN M., BARNEKOW-BERGVIST M.

Centre for Musculoskeletal Research, University of Gävle, Sweden

### Aims:

Many questionnaires addressing pain and function in neck pain are modified back-specific measures. The experience of neck pain patients is seldom accounted for in the questionnaire development, although input from the target group is recommended in order to increase validity [1]. The present study introduces the new neck-specific Profile Fitness Mapping questionnaire (ProFitMap-neck), which was clinically derived and based on patient's self-reported characteristics of their neck problems. The ProFitMap-neck consists of a functional limitation and a symptom scale, with the latter subdivided in separate indices for severity and temporal aspects. The aim of the study was to assess the overall validity and reliability of the ProFitMap-neck.

### Methods:

Chronic non-specific neck pain subjects (n=104) answered the ProFitMap-neck and three validated criterion questionnaires; The Neck Disability Index (NDI), The Functional Self-Efficacy Scale (SES) and the SF-36. Internal consistency (Cronbach's alpha), concurrent criterion validity (linear correlations between questionnaire scores), construct validity (ability to discriminate subjects with different pain severities) and content validity (distribution of the ProFitMap-neck indices) were assessed. Also, test-retest reliability (ICC) with one week test interval was evaluated in a subgroup (n=45).

### Results:

The Cronbach's alpha for the ProFitMap-neck indices was high (0.88-0.95) and the total index showed good correlation with NDI and the SF-36 subscales physical functioning and bodily pain. The same SF-36 subscales as well as NDI, SES and the function index and total index of ProFitMap-neck could discriminate between three out of four categories of pain severity (one-way ANOVA and post hoc tests). The score distribution of each ProFitMap-neck index was normally distributed (mean range 60.0-67.9, scale 0-100) with no subject scoring the highest or lowest possible score. The ICC was slightly higher for the ProFitMap-neck function index and total index (0.91 and 0.90, respectively) than for the symptom indices intensity and frequency (0.80 and 0.83, respectively). This may reflect a larger variation in symptoms compared to function associated with neck pain.

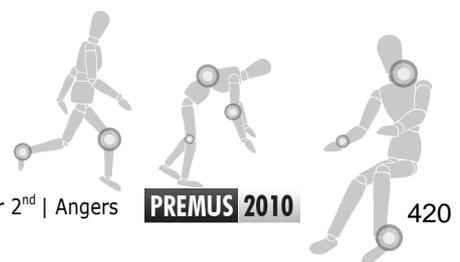
### Conclusion:

The present study indicates that the ProFitMap-neck is a valid and reliable measure of symptoms and functional limitations in chronic neck pain subjects. The combination of a composite total index of symptoms and function as well as separate indices of each makes it suitable for research as well as in clinical practice.

**Keywords:** Neck, pain, chronic pain, specific health outcomes.

### Reference:

Wiiitavaara B, Björklund M, Brulin C, Djupsjöbacka M. How well do questionnaires on symptoms in neck-shoulder disorders capture the experiences of those who suffer from the disorders? A content analysis of questionnaires and interviews. BMC Musculoskeletal Disorders. 2009 Mar 9;10:30.



## USE OF JOB-SPECIFIC FUNCTIONAL CAPACITY EVALUATION TO PREDICT THE EMPLOYMENT STATUS OF PATIENTS WITH NONSPECIFIC LOW BACK PAIN

CHENG A.S.K., CHENG S.W.C

### **Aims:**

To examine the predictive validity of a job-specific functional capacity evaluation on the employment status of patients with nonspecific low back pain.

Functional capacity evaluation (FCE) is a common clinical tool to evaluate work ability and to provide return-to-work recommendations. However, several studies have reported that its predictive validity is low. In order to improve its predictive validity, a job-specific FCE was advocated and investigated.

### **Methods:**

All selected patients with nonspecific low back pain underwent FCE in designated work rehabilitation centers under the Hospital Authority of Hong Kong between April 2004 and March 2007. Based on their performance, return-to-work recommendations were given. Three months after evaluation, all patients were contacted by telephone to find out their employment status in order to examine the predictive validity of each FCE-based rating. The effect of confounding variables on the predictive validity was studied by both univariate and multivariate logistic regression. Finally, regression model for each FCE-based rating on the correct prediction of employment status with significant confounding variables were built.

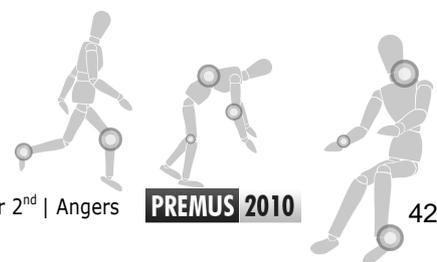
### **Results:**

A high percentage of correct predictions was observed for recommendations to return to previous job and to change job when compared with recommendations to return to previous job with modification. The correct prediction from an FCE pass rating was 79.8%; fail rating due to not meeting all the criteria of FCE tasks was 61.7%; and fail rating due to failing all FCE tasks was 68.4%. The results of both the univariate and multivariate logistic regressions showed that days from injury to FCE, compensability, and a very heavy physical demand level of the job had a statistically significant effect ( $p < 0.05$ ) on reducing the predictive validity of job-specific FCE.

### **Conclusion:**

Use of a job-specific FCE could provide a high predictive validity of the employment status of patients with nonspecific chronic LBP.

**Keywords:** Job-specific functional capacity evaluation, nonspecific low back pain, predictive validity, employment status.



## WORKING DESPITE CHRONIC NONSPECIFIC MUSCULOSKELETAL PAIN: A QUALITATIVE STUDY

VRIES DE H.J., BROUWER S., GROOTHOFF J.W., GEERTZEN J.H.B., RENEMAN M.F.

*Center for Rehabilitation, University Medical Center Groningen, University of Groningen, The Netherlands - Graduate School of Medical Sciences, University Medical Center Groningen, University of Groningen, The Netherlands*

### **Aims:**

Although many people with chronic nonspecific musculoskeletal pain (CMP) have decreased workability, the majority is staying at work despite pain. The aim of this study was to explore why people with CMP decide to stay at work despite pain, and how they are able to maintain in the workforce. Themes identified in this study probably could help clinicians to identify successful ways of staying at work and coping with CMP. The effectiveness of vocational rehabilitation programs could be increased when success factors for staying at work become clear.

### **Methods:**

A semi-structured interview was conducted in 20 participants with CMP (9 male, 11 female) who work despite CMP. Criterion-based sampling was used to ensure the sample contained a rich mix of different perspectives according to gender, age, social background and occupation. Interviews lasted 45-90 minutes and were audio recorded and transcribed verbatim. Computer software Atlas.ti was used for data analysis. The analyses were done by the interviewer in close collaboration with a second researcher. Data was analysed continuously until saturation was achieved.

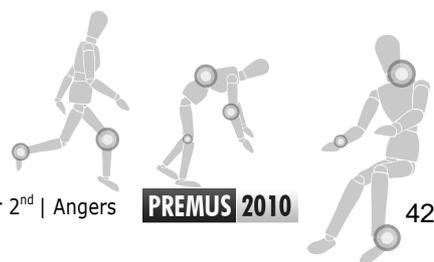
### **Results:**

Transcripts are made and the interviews are open-coded. Currently, data are analysed and interpreted. Results will be presented during PREMUS.

### **Conclusion:**

Discussion and conclusion will be presented during PREMUS.

**Keywords:** Psychosocial factors, Disability prevention, Pain, Chronic pain



## THE WORK ROLE FUNCTIONING QUESTIONNAIRE AND CHRONIC MUSCULOSKELETAL DISORDERS: HAS IT A CLINICAL STUDY (RESULTS FROM A PROSPECTIVE STUDY OF 539 WORKERS)?

FOUQUET B., BADAOU S., PELLIEUX S., METIVIER J.C., BORIE-MALAVIEILLE M.J.

University of Tours - Physical Medicine and Rehabilitation Center, Hôpital Trousseau- CHU, 37044 Tours, France

### Aims:

The Work Role Functioning Questionnaire (WRFQ) is a work disability scale assessing the impact of health problems on the worker's ability to perform his job according to five domains. Very few studies have aimed to evaluate the clinical utility of such scale.

The objective of this study was to evaluate the clinical utility of the WRFQ in a population of chronic musculoskeletal disorders.

### Methods:

539 workers (mean age 42.9; S.D. 9 years, 211 men and 328 women) have been included in this prospective study, from January 2005 to July 2008, with mean work disability duration of 10.5 months. Only 160 workers were still at work at the beginning of the follow-up. All were assessed using different scales about their mood, job satisfaction and disability, and the Karasek's questionnaire and the French version of the WRFQ [1].

### Results:

Workers still at work have higher scores for "work scheduling" ( $p < 0.002$ ), "output" ( $p < 0.0001$ ), "physical" ( $p < 0.0004$ ), "mental" ( $p < 0.003$ ) and "social" ( $p < 0.006$ ) demands of the WRFQ than workers with work disability. We found the highest correlations between job satisfaction and "work scheduling" and "output" demands. "Psychological demand" scores of the Karasek's scale and the FABQ "work" scores were highly correlated with the "work scheduling", "output" and the "physical" demands scores of the WRFQ. Significant differences were observed in function of the aetiology of the musculoskeletal disorders. Changes in the work place were associated with lowest scores in the "output" and "work scheduling" demands scales. Patients with highest FABQ "work" scores associated with low WRFQ "output" scores differed from the others regarding the psycho-affective, psychosocial and disabilities scales and the social outcome.

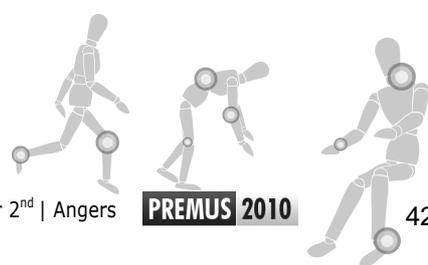
### Conclusion:

The WRFQ could help in a better clinical biopsychosocial approach during multidisciplinary evaluation of worker's musculoskeletal disorders. It could, in association with the FABQ "work", help to discriminate workers prognosis of return to work.

**Keywords:** Psychosocial factors, Personal risk factors for MSD, Prognosis of MSD.

### Reference:

Durand MJ, Vachon B, Hong QN, Imbeau D, Amick BC 3rd, Loisel P, The cross-cultural adaptation of the Work Role Functioning Questionnaire in Canadian French. *Int J Rehabil Res* 2004;27(4):261-268



## WORK ABILITY AMONG SENIOR WORKERS (50+) IN A CONSTRUCTION COMPANY

JEBENS E., MEDBØ J.I., KNUTSEN O., MAMEN A., VEIERSTED K.B.

National Institute of Occupational Health, Oslo, Norway.

### Aims:

Work in the construction industry is physically demanding, and that may influence the workers' health. Musculo-skeletal disorders constitute the greatest cause of disability pension in the trade. Moreover, senior construction workers that report lasting health problems, have the largest tendency to retire early. The aim of our study was to analyze factors that may force seniors to retire before the age of normal retirement (67 years, national insurance).

Main questions addressed in this study:

- Is perceived workload exposure related to age?
- Is neck/shoulder pain related to age?
- Is muscle strength lower in workers aged 50+ yr?
- Do shoulder strength and function vary much between workers?
- Is self-reported workload related to pain and/or muscle strength?

### Methods:

This was a cross-sectional study, screening all employees (n = 90 men) in a construction company for anthropometric data, musculoskeletal pain (Steingrimsdottir 2005) and perceived mechanical work load exposure (Balogh 2001). Muscle strength (e.g. maximal shoulder press using both arms) was measured for 20 young workers aged <30 yr and 20 senior workers aged 50+ yr.

### Results:

The perceived mechanical work load exposure was similar among young and senior workers, but there were large variations within each age group.

There was no correlation between neck/shoulder pain and neither shoulder strength nor perceived work load. There were more severe cases of neck and shoulder pain among senior workers than among young workers. However, most seniors with weak shoulders also have a low level of neck/shoulder pain. The older workers were weaker in the shoulder-press test, and several seniors were unable to lift more than 15 kg because of inadequate shoulder function.

Seniors with neck/shoulder pain reported low to moderate mechanical exposure. There was thus no relationship between perceived work load and shoulder strength.

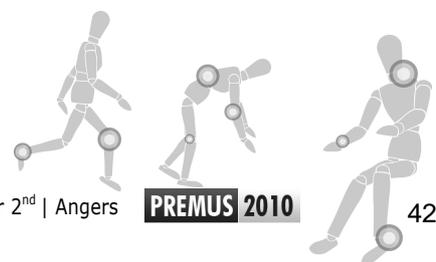
### Conclusion:

Muscle strength in the neck, shoulder and upper back region (shoulder press) decreased by age. Some seniors had poor shoulder performance of unknown cause. There were no relationships between measured muscle strength, reported mechanical exposure, or neck/shoulder pain.

**Keywords:** Construction, Older workers, Upper limb

### References:

Steinsgrímdóttir O.A. Subjective health complaints and their relation to muscle responses in a working population. Thesis, Faculty of Medicine, University of Oslo 2005.  
Balogh I, Ørbaeck P, Winkel J, Nordander C, Ohlsson K, Ektor-Andersen J, Malmö Shoulder-Neck Study Group. Questionnaire-based mechanical exposure indices for large population studies – reliability, internal consistency and predictive validity. Scand J Work Environ Health 2001; 27(1):41-48



## ELDERLY WORKERS IN PHYSICALLY DEMANDING JOBS: HOW DO THEY MANAGE?

MEDBØ J.I., JEBENS E., MAMEN A., KNUTSEN O., VEIERSTED K.B.

National Institute of Occupational Health, Oslo, Norway

### Aims:

Work in the construction industry is physically demanding and influence the workers' physical resources. The construction industry is the second largest branch for disability retirement for the workers >60 yr old, mainly because of musculo-skeletal disorders. Senior construction workers that report lasting health problems or feel they are worn out, have the largest tendency to retire early.

Physical ability is normally reduced by age. Many workers with physically demanding tasks assume that they maintain their physical work ability through their work. This may not be correct. If so, elderly workers may be at disadvantage in physically demanding work. We have here examined physical ability and demands during work among young and senior construction workers to see whether the demand on senior construction workers may exceed their ability.

### Methods:

First a survey (questionnaires) was carried out among all employees in a medium-sized construction company (n = 100). Thereafter 40 construction workers (20 above 45 yr, 20 below 30 yr) were tested for muscular strength, cardio-respiratory fitness, and body fatness. Finally, 18 of the older and 12 of the younger workers were followed for 1 h each during their normal work while oxygen uptake and heart rate were measured continuously by automatic analysers.

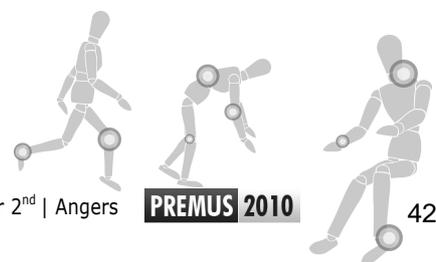
### Results:

Having good health / not being worn out was reported as the most important requirement for staying in work to normal age of retirement. Most of the workers stated that the work was medium to very strenuous, that they had demanding working positions and that they had daily handling of tools and equipment weighing 1-45 kg. The young workers had a higher VO<sub>2</sub>-max than the seniors: 53 vs. 41 ml kg<sup>-1</sup> min<sup>-1</sup>. For both groups the work taxed on average 31% of VO<sub>2</sub>-max and 53% of HR-max. Peak loads for a few minutes duration were 54% of VO<sub>2</sub>-max and 71% of HR-max.

### Conclusion:

For both age groups VO<sub>2</sub>-max was typical for untrained persons of their age, suggesting that their work did not improve their fitness. During work both groups taxed their aerobic power similarly and equal to the internationally suggested level of 30% of VO<sub>2</sub>-max averaged over an 8 h working day. These data suggest that elderly workers, when given the possibility, may adjust the physical demands to a level they can sustain. However, for some unfit seniors the aerobic demand may exceed the proposed upper limit.

**Keywords:** Postures, Physical exposure, Construction, Older workers



## STRENGTH AND LUMBAR RANGE OF MOTION RELATED TO LOW BACK PAIN (LBP) AND AGE

MEYER J.P., FLENGHI D.

*INRS, Vandoeuvre, France; IUFM Reims, France*

### Aims:

Record functional capacities and LBP status in a working population to explore the relationships between function and LBP in healthy subjects.

### Methods:

1800 workers (700 women and 1100 men; 18 to 62 years) volunteered and were chosen while exposed to whole body vibration (WBV), manual handling (MH) or long sitting posture (P). Recorded parameters were: hip flexion and spinal frontal and sagittal flexions and maximal isometric forces of trunk flexion and extension and right and left grip. LBP was described by 2 clinical features (maximal level and number of events) and 3 time periods: last year, past between 1 to 3 years and past more than 3 years.

### Results:

More than two third of the population has a LBP history but only 25% was on sick leave due to LBP. Exposures to WBV, MH or P have no effect on LBP prevalence. But WBV and MH increase sciatica incidence, sick leave number and duration ( $p < .001$ ).

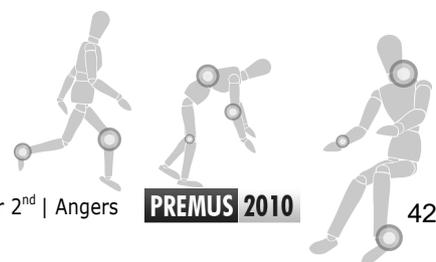
All mobilities are decreasing with age ( $p < .0001$ ). The ratio of sagittal to frontal flexions is increasing with age ( $p < .001$ ). Mobilities are poorly predictive of LBP. They are decreasing more than strength with ageing. Even trunk extension strength is not decreasing with age. Strengths are significantly related to the maximal level of LBP but not to the event number. Trunk extension to flexion strengths ratio has no effect on LBP. But the ratio of grip to trunk extension strengths is linearly related to LBP maximal level ( $p < .01$ ) and to sick leave ( $p < .05$ ).

Sick leaves are related to strenghts (trunk flexion and grip;  $p < .05$ ) and higly ( $p < .0001$ ) to LBP events number and less to their maximal level. In our study, sick leave due to LBP is not related to satisfaction at work nor to other psychosocial parameters.

### Conclusion:

Functional capacities recorded in our study do not explain much of LBP clinical aspects. Strength can protect the low back but balance between peripheral (grip) and central (trunk flexions) seems to be more important. However, the increase of the force ratio between hand and trunk extension is of interest and in line with a biomechanical explanation of injury coming from a peripheral stress unacceptably high for the central capacities. At last, our results show that if epidemiological analysis of functional capacities could give knowledge about a general LBP phenomenon, a clinical approach remains the most effective to take care of LBP sufferers.

**Keyword:** Muscle activity, older workers, back, low back



## DOES FUNCTIONAL CAPACITY DECLINE IN HEALTHY AGEING WORKERS?

SOER R., BROUWER S., GEERTZEN J.H.B., GROOTHOFF J.W., RENEMAN M.F.

*Department for Rehabilitation Medicine, Center for Rehabilitation, University Medical Center Groningen, University of Groningen, the Netherlands.*

### **Aims:**

To study the influence of ageing on functional capacity (FC) and to compare FC to categories of workload.

### **Methods:**

FC was measured cross-sectionally with a 14-item Functional Capacity Evaluation (FCE) in a sample of 701 healthy workers between 20 and 60 years. Workload was expressed by the workload categories as described by the Dictionary of Occupational Titles (DOT). Descriptive statistics were used to show FC of workers in different age groups.

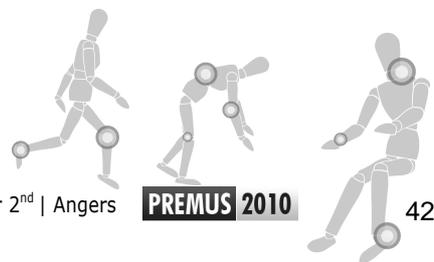
### **Results:**

Differences in FC from the theoretical highest to lowest FC in age group varied from +2% in handgrip strength to -25% in overhead work. For females, FC of 4 out of 14 tests significantly declined with age. In men's FC, 9 out of 14 tests were subject to decline over age. Main difference between the decline in FC between men and women were the significant decline in material handling tasks for men, where women did not decline. Men working in physical heavy work, appear to suffer the most from the decline because a large part of this group will be unable to meet their work demands in terms of the DOT.

### **Conclusion:**

There is large variety in decline in FC over age between 20 and 60, however in general, material handling tests, coordinative tests and energetic capacity appear to decline the most. It is of great importance to gain longitudinal data of the decline in FC in ages above 60 years of age.

**Keywords:** Postures, Physical exposure, Disability prevention, Older workers



## WORKING DESPITE CHRONIC NONSPECIFIC MUSCULOSKELETAL PAIN: A QUALITATIVE STUDY

VRIES DE H.J., BROUWER S., GROOTHOFF J.W., GEERTZEN J.H.B., RENEMAN M.F.

*Center for Rehabilitation, University Medical Center Groningen, University of Groningen, The Netherlands - Graduate School of Medical Sciences, University Medical Center Groningen, University of Groningen, The Netherlands*

### **Aims:**

Although many people with chronic nonspecific musculoskeletal pain (CMP) have decreased workability, the majority is staying at work despite pain. The aim of this study was to explore why people with CMP decide to stay at work despite pain, and how they are able to maintain in the workforce. Themes identified in this study probably could help clinicians to identify successful ways of staying at work and coping with CMP. The effectiveness of vocational rehabilitation programs could be increased when success factors for staying at work become clear.

### **Methods:**

A semi-structured interview was conducted in 20 participants with CMP (9 male, 11 female) who work despite CMP. Criterion-based sampling was used to ensure the sample contained a rich mix of different perspectives according to gender, age, social background and occupation. Interviews lasted 45-90 minutes and were audio recorded and transcribed verbatim. Computer software Atlas.ti was used for data analysis. The analyses were done by the interviewer in close collaboration with a second researcher. Data was analysed continuously until saturation was achieved.

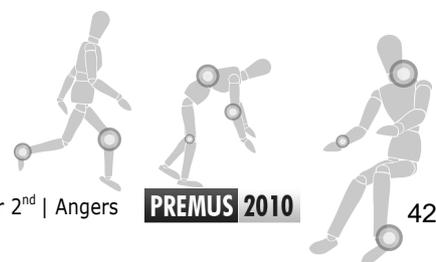
### **Results:**

Transcripts are made and the interviews are open-coded. Currently, data are analysed and interpreted. Results will be presented during PREMUS.

### **Conclusion:**

Discussion and conclusion will be presented during PREMUS.

**Keywords:** Psychosocial factors, Disability prevention, Pain, Chronic pain



## PROFESSIONAL BASED CLASSIFICATION VERSUS SELF REPORTED MEASURES AS A BASIS FOR CHOICE OF INTERVENTION - PATIENTS WITH MUSCULOSKELETAL AND MENTAL DISORDERS

WÅHLIN NORGRÉN C., EKBERG K., ÖBERG B.

*Department of Medical and Health Sciences, Linköping University, Sweden*

### **Aims:**

The aim of this study is to analyse if there is an agreement of professional assessment of patients' health and main clinical problem compared to self-rated health, functioning, activity limitation, social support, work ability, work conditions and, how this is related to choice of treatment.

### **Methods:**

A cross-sectional study enrolling patients with musculoskeletal disorders (MSD) and/or mental disorders (MD) was conducted at an occupational health service. Physicians' and physiotherapists summarized the clinical findings according to ICD-10, the patients' main clinical problem and type of recommended intervention.

The patients answered a questionnaire including demographic variables, dimensions of health, functioning, social support, work ability, and work conditions. The patient specific functional scale (PSFS) was used to capture activity limitations. Factors explaining choice of intervention was explored.

### **Results:**

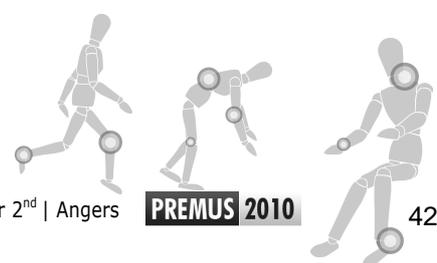
The study included 210 patients (182 women). According to ICD-10, 44% had MSD, 22% had MD, and 34% had a combination of MSD and MD. The three groups of main clinical problem were; medical/organical problem (38%), psychosocial problem (46%) and physical work related problems (15%). The group with medical/organical problems had limitations for performing activities in all dimensions according to PSFS; physical activities, social interaction, cognitive, and work related tasks. All patients' in the psychosocial group identified limitations concerning social interaction. The group who had physical work related problems reported work related tasks as most difficult.

Over half of the patients (58%) were recommended workplace interventions. The group with medical/organical problems was recommended individual interventions to a higher degree (54%) in comparison with the other two groups. Having poor work ability and having difficulties with social interaction according to PSFS increases the possibility of receiving workplace intervention. Patients' who have low social support and poor mobility are more likely to receive individual interventions.

### **Conclusion:**

There is an agreement between professional and patients' perspectives when health, function, work ability, work conditions and activity limitations are classified. The broader biopsychosocial framework for identifying patient's health situation and main clinical problem can be a useful complement to the medical diagnostic procedure. Interestingly, the PSFS seems to capture activity limitations for both patients' with MSD and MD. The professional classification into the main problem did not influence the choice of treatment, but there were obvious patterns in the different groups according to both in self-reports as well as with PSFS.

**Keywords:** Personal risk factors for MSD, return to work, pain, chronic pain



## PROGNOSIS AND RECURRENCE

### PSYCHOSOCIAL RISK FACTORS FOR TRANSITION FROM ACUTE TO CHRONIC LOW BACK PAIN IN PRIMARY HEALTH CARE. REVIEW OF THE LITERATURE

RAMOND A., BOUTON C., RICHARD I.

*Département de médecine générale, Faculté de médecine, Université d'Angers, France*

#### Aims:

Low back pain (LBP) is a major public health problem, often encountered in primary care. Recent guidelines recommend early identification of psychosocial factors which could prevent rapid recovery from acute LBP [1]. This study was aimed at systematically reviewing the evidence on the prognostic value of psychosocial factors for transition from acute to chronic non-specific LBP in adult general population

#### Methods:

A systematic search for prospective studies dealing with psychosocial risk factors for poor evolution in LBP was conducted, screening Pubmed, PsychInfo and Cochrane Library databases. Cohort studies were selected if adults with (sub)acute (< 3 months) LBP in primary care were followed-up during at least three months, and evaluated with patient-centered outcome criteria. Methodological quality of studies was assessed independently by two reviewers using standardized criteria before analysing their main results.

#### Results:

23 papers fulfilled the inclusion criteria, related to 18 different cohorts. 16 psychosocial factors were analyzed, belonging to 3 domains : social and socio-occupational, psychological, and cognitive and behavioral fields. Depression, emotional distress, passive coping strategies and fear-avoidance beliefs were sometimes found to be independently linked with poor outcome, whereas most social and socio-occupational factors were not. patient's self-perceived general health at baseline was of significant predictive value. Initial patient's or caregiver's perceived risk for LBP persistence was the factor the most constantly linked with actual evolution [2].

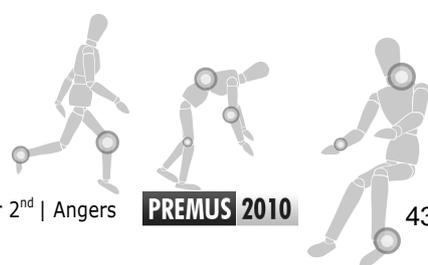
#### Conclusion:

This study found few independent psychosocial risk factors, which never explained a large part of observed variability in evolution of episodes of LBP in primary health care. Randomized clinical trials aiming at modifying them have shown little impact on prognosis on a cohort scale [3]. Deeper understanding about these psychosocial issues is probably needed before defining new management strategies. Qualitative research could be a suitable method to explore further and differently the field of LBP.

**Keywords:** Psychosocial factors, Back, low back, Prognosis of MSD.

#### References:

- [1] van Tulder M, Becker A, Bekkering T, Breen A, del Real MT, Hutchinson A, et al. Chapter 3. European guidelines for the management of acute nonspecific low back pain in primary care. *Eur Spine* J2006 Mar;15 Suppl 2:S169-91.
- [2] Henschke N, Maher CG, Refshauge KM, Herbert RD, Cumming RG, Bleasel J, et al. Prognosis in patients with recent onset low back pain in Australian primary care: inception cohort study. *BMJ*2008;337:a171
- [3] Moore JE, Von Korff M, Cherkin D, Saunders K, Lorig K. A randomized trial of a cognitive-behavioral program for enhancing back pain self care in a primary care setting. *Pain*2000 Nov;88(2):145-53



## RISK FACTORS FOR REDUCED PRODUCTIVITY AMONG YOUNG ADULTS WITH MUSCULOSKELETAL SYMPTOMS IN NECK OR UPPER EXTREMITY – A PROSPECTIVE COHORT STUDY

BOSTRÖM M., DELLVE L., THOMÉE S., HAGBERG M.

*Dept of Occupational & Environmental Medicine, Gothenburg, Sweden*

### Aims:

This study prospectively assessed the importance of individual conditions and computer use during school or work and leisure time as risk factors for self-reported generally reduced productivity due to musculoskeletal complaints among young adults with musculoskeletal symptoms in the neck or upper extremities.

### Methods:

A cohort of 2914 young adults (18–25 years, vocational school and college or university students) responded to an internet-based questionnaire concerning musculoskeletal symptoms related to individual conditions and computer use during school or work and leisure time that possibly affected general productivity. Prevalence ratios (PR) were used to assess prospective risk factors for generally reduced productivity.

### Results:

The selected study sample (N=1051) had reported neck or upper-extremity symptoms. At baseline, 280 of them reported reduced productivity. A follow-up of the 771 who reported no reduced productivity was carried out after 1 year. Risk factors for self-reported generally reduced productivity for those followed-up were symptoms in two or three locations or dimensions for the upper back or neck and the shoulders, arms, wrists, or hands [PR 2.30, 95% confidence interval (95% CI) 1.40–3.78], symptoms persisting longer than 90 days in the shoulders, arms, wrists, or hands (PR 2.50, 95% CI 1.12–5.58), current symptoms in the shoulders, arms, wrists, or hands (PR 1.78, 95% CI 1.10–2.90) and computer use 8–14 hours/week during leisure time (PR 2.32, 95% CI 1.20–4.47). A stronger relationship was found if three or four risk factors were present. For women, a relationship was found between generally reduced productivity and widespread and current symptoms in the upper extremities.

### Conclusion:

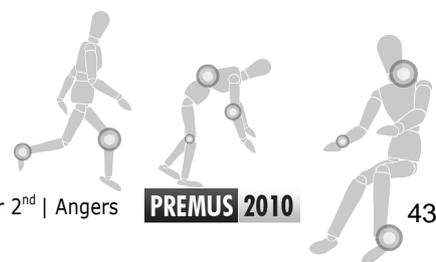
The main risk factors for generally reduced productivity due to musculoskeletal symptoms among young adults in this study were chronic symptoms in the upper extremities and widespread symptoms in the neck and upper extremities.

Published in: Boström M, Dellve L, Thomée S, Hagberg M. Risk factors for generally reduced productivity—a prospective cohort study of young adults with neck or upper-extremity musculoskeletal symptoms. *Scand J Work Environ Health*. 2008;34(2):120–132.

**Keywords:** Computer work, Early prevention, Pain, chronic pain

### References:

- Koopmanschap M, Burdorf A, Jacob K, Meerding WJ, Brouwer W, Severens H. Measuring productivity changes in economic evaluation: setting the research agenda. *Pharmaco-economics*. 2005;23(1):47–54.
- Hagberg M, Vilhemsson R, Tornqvist EW, Toomingas A. Incidence of self-reported reduced productivity owing to musculoskeletal symptoms: association with workplace and individual factors among computer users. *Ergonomics*. 2007;50(11):1820–34.
- Burdorf A. Economic evaluation in occupational health—its goals, challenges, and opportunities [editorial]. *Scand J Work Environ Health*. 2007;33(3):161–4.



## PRESSURE PAIN THRESHOLDS AT DIFFERENT BODY REGIONS IN CHRONIC MUSCULO-SKELETAL DISORDERS (MSD) VS HEALTHY

NAKATA M.<sup>1,2,5</sup>, YOSHIZAWA M.<sup>3</sup>, YAMADA Y.<sup>1</sup>, KAGECHIKA K.<sup>2</sup>, ERIKSSON P.O.<sup>4,5</sup>

<sup>1</sup> Department of Hygiene, Kanazawa Medical University, Uchinada, Japan - <sup>2</sup> Department of Rehabilitation Medicine, Kanazawa Medical University, Uchinada, Japan - <sup>3</sup> Faculty of Education and Regional Studies, University of Fukui, Fukui, Japan - <sup>4</sup> Clinical Oral Physiology, Umeå University, Umeå, Sweden - <sup>5</sup> Centre for Musculoskeletal Research, University of Gävle, Umeå, Sweden,

### Aims:

Since musculoskeletal pain is a cardinal symptom in chronic MSD, assessment of pain thresholds may help in distinguishing patient groups from healthy subjects. The aim of the present study was to test the hypothesis that MSD show low thresholds for pressure pain in wide spread body areas, and that MSD of different origins may show separate pressure pain profiles.

### Methods:

#### 1. Subjects

The study was performed in 54 Whiplash-Associated Disorders (WAD) individuals (15 males, 39 females;  $41.3 \pm 11.5$  of age) and 88 Stress-Related Disorders (SRD) individuals (18 males, 70 females;  $43.1 \pm 9.8$  of age) examined at University hospitals in Sweden and Japan. Twenty healthy Swedish subjects (4 males, 16 females;  $42.7 \pm 9.0$  of age) were examined as a control group.

#### 2. Pressure-pain threshold

Pressure-pain thresholds of the trapezius pars descendens, erector spinae at L3-L4 level, and spinous processes from C5 to L5 were recorded using a strain-gauge sensor. The tip of the sensor was pressed gradually at a speed of approximately 0.5 kilogram-force (kgf)/second against the muscles/spinous-processes until the subject expressed pain.

All examinations were performed by one of the authors (MN).

### Results:

1. Pressure-pain thresholds of the right trapezius for the WAD, SRD, and control groups were  $1.3 \pm 0.7$ ,  $1.7 \pm 0.9$ , and  $2.7 \pm 1.1$ , respectively. Significant differences were observed among the three groups ( $p \leq 0.05$ ). Similar result was seen on the left side.

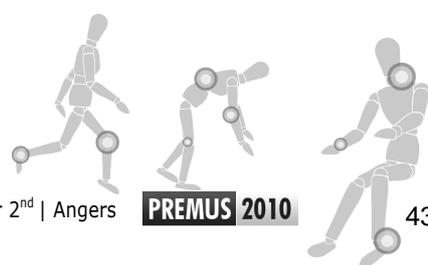
2. Pressure-pain thresholds of the right erector spinae for the WAD, SRD, and control groups were  $2.1 \pm 1.4$ ,  $2.5 \pm 1.2$ , and  $4.4 \pm 1.7$ , respectively. Significant differences were observed between the WAD/SRD groups and the healthy control group ( $p \leq 0.05$ ). Similar result was observed on the left side.

3. Pressure-pain thresholds of the spinous processes of WAD revealed the lowest levels, followed by SRD, and significantly lower than in healthy ( $p \leq 0.001$ ).

### Conclusion:

The finding of significantly lower pressure pain thresholds in WAD and SRD than in healthy controls support our hypothesis of low thresholds for pressure pain in MSD. Low thresholds in wide spread body areas may reflect central sensitization. Similar patterns of spread of pain sites in WAD and SRD, but lower pressure pain thresholds in WAD may indicate differences in pathogenesis between these two maladies.

**Keywords:** Exposure measurement methods, Intervention studies, Prognosis of MSD.



## OCCUPATIONAL OUTCOME IN 2007-2008 OF WORKERS SUFFERING FROM MUSCULOSKELETAL DISORDERS IN THE FRENCH PAYS DE LA LOIRE REGION

SERAZIN C., BODIN J., HA C., TASSY V., TOURANCHET A., BIDRON P., MERITET F., LEDENVIC B., LEROUX F., MAZOYER A., IMBERNON E., ROQUELAURE Y.

Laboratoire d'Ergonomie et d'Epidémiologie en Santé au Travail (LEEST), Faculté de médecine, Angers, France

### Aims:

A French program of epidemiological surveillance implemented in 2002 in the Pays de la Loire region revealed a prevalence of 13% for the 6 most frequent upper extremity musculoskeletal disorders (UEMSDs) among a sample of salaried workers: rotator cuff syndrome, lateral epicondylitis, flexor-extensor peritendinitis of the hands and fingers, De Quervain's disease, carpal tunnel syndrome and ulnar tunnel syndrome. The aim of this study is to describe the occupational outcome of these workers a few years later.

### Methods:

From 2002 to 2004, 83 occupational physicians examined 3,710 workers randomly selected [1], following the recommendations of the European consensus Saltsa [2]. 3 groups were constituted:

- Group 1: workers with no upper limb pain during the past 7 days (49% of the sample)
- Group 2: workers with pain during the past 7 days but without any clinical diagnosed form of UEMSDs (38%),
- Group 3: workers with at least one clinically diagnosed UEMSD (13%)

In 2007 and 2008, they received by mail a questionnaire about their occupational activities.

### Results:

2,332 people responded. Workers were older in group 3. After adjusting for age, we found as many retired people in the 3 groups. Among the non-retired workers (table), those who were not working were more numerous in group 3 and less numerous in group 1 ( $p=0.0007$ ). Among those still at work, the percentage of workers who have changed their working station since 2002-2004 differed between groups ( $p=0.04$ ): 24% have changed their working station in the same company in group 2 (vs 19% in group 1 and 21% in group 3), and 16% have moved to another company in group 2 (vs 14% and 10%, respectively).

Table : Occupational status in 2007 and 2008 for the workers, according to their musculoskeletal problems in 2002-2004

Clinical Status in 2002-2004	Group 1 (no pain)		Group 2 (pain)		Group 3 (proven disorder)	
	n	%	n	%	n	%
Occupational status en 2007 -2008						
Still at work	1,366	95	396	92	234	89
Non-working people, for another reason than retirement	72	5	34	8	28	11

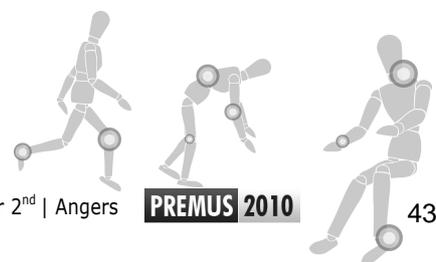
### Conclusion:

This study shows that the occupational outcome varies according to the previous UEMSDs status.

**Keywords:** Surveillance, Epidemiology, Return to work

### References:

- [1] HA C, ROQUELAURE Y, LECLERC A, TOURANCHET A, GOLDBERG M, IMBERNON E. The French musculoskeletal disorders surveillance program: Pays de la Loire network, Occupational and Environmental Medicine 2009; 66: 471-9.  
 [2] SLUITER JK, REST KM, FRINGS-DRESEN MHW. Criteria document for evaluation of the work-relatedness of upper extremity musculoskeletal disorders. Scand J Work Environ Health 2001;27 suppl 1: 1-102.



## RECURRENCE OF LOW BACK PAIN: INJURED WORKERS' PERSPECTIVES

YOUNG A.E., WASIAK R., PHILLIPS L.A., GROSS D.P.

*Liberty Mutual Research Institute for Safety, USA*

### **Aims:**

Currently there is no consensus on measuring low back pain (LBP) recurrence. While measures are available (repeated pain episodes, functional impact, healthcare utilization, work disability) each describes a different aspect of the condition and none have been investigated for consistency with patients' perceptions. To further understanding of LBP, we examined how individuals with a history of LBP describe pain events.

### **Methods:**

Since we wanted to understand individuals' experiences and the nested contexts of the LBP phenomenon, a qualitative approach was chosen. Focus groups were used as conversation involving others in a similar situation often results in expression and storytelling. Six mixed-gender focus groups were conducted. These were facilitated by two researchers experienced in qualitative methods. The groups were structured around predetermined questions read by one of the researchers. Participants were encouraged to answer and reflect on the responses made by others. Audio recordings were fully transcribed and content analyzed. Thematic congruence was achieved through coding and discussion of four independent researchers.

### **Results:**

Participants included 31 individuals (14 females, 17 males), with ages ranging from early 20s to mid 70s. Occupations included laborers, professionals, students and individuals receiving wage-replacement benefits. When asked about LBP recurrence participants had difficulty understanding the concept. There was a sense that although the pain may disappear, it was always there: "It's a constant and a reoccurrence – it comes and goes and comes and goes, but it's always there. Even the anxiety of it is always there." When asked about the similarity of repeated episodes, the sentiment was such that later episodes were the same: "same spasm, same place. The injury was re-awoken". When talking about experiences participants indicated their condition was sometimes worse than others. Three pain states were defined: 'normal', 'flared up/aggravated' and 'having an attack'. 'Normal' could include experiencing pain, but generally represented a tolerable state. 'Flared up' was associated with increased pain levels, the use of strategies to overcome difficulties, and modified participation. 'Attack' state was described as severely disabled: "I just have to lay there".

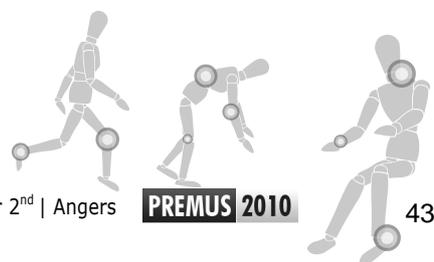
### **Conclusion:**

Individuals with LBP describe the phenomenon as a disabling health condition influenced by personal and environmental factors. Subjects had difficulty conceptualizing the concept of recurrence, considering the condition as always present even if pain had gone. Results cast doubt on the validity of currently available measures of LBP recurrence.

**Keywords:** Return to work, back, low back, specific health outcomes

### **References:**

- Wasiak R, Young AE, Dunn KM, Cote P, Gross DP, Heymans MW, et al. Back pain recurrence: an evaluation of existing indicators and direction for future research. *Spine (Phila Pa 1976)*. 2009 Apr 20;34(9):970-7.
- Wasiak R, Pransky GS, Webster BS. Methodological challenges in studying recurrence of low back pain. *J Occup Rehabil*. 2003 Mar;13(1):21-31.
- Pengel LH, Herbert RD, Maher CG, Refshauge KM. Acute low back pain: systematic review of its prognosis. *Bmj*. 2003 Aug 9;327(7410):323.



## THE "VIBROSENSE®": SCREENING AND FOLLOW-UP OF NEUROLOGICAL DAMAGE BY HAND-ARM VIBRATIONS

DUPREZ H.

*Adhesia (External Service for Prevention at Work), Belgium*

### Aims:

The Vibrosense® is an instrument for measuring the threshold of feeling vibrations with the fingertip. Patients indicate whether they feel not the vibrations of various frequencies and various amplitude. The Vibrosense® calculates the "Sensibility-index" (SI) of each finger. I tried to find out if the Vibrosense® is useful in early detection and in the follow-up of the evolution of neurological lesions caused by vibrations.

### Methods:

Two groups of male workers were examined with the Vibrosense® : group 1 "exposed to vibrations" (N=68) versus group 2 "not exposed", but with heavy manual work (N=40). The groups were statistically not different in age ( $p=0,683$ ) and working years ( $p=0,138$ ). All filled in a validated questionnaire, followed by examination with the Vibrosense®.

The average number of hours exposure in group 1 was 16,65 h per week (2 – 36,5). To compare the total time of exposure, I calculated a score by multiplying the exposure / week by the years of exposure.

Exclusion criteria were : neurological diseases, diabetes mellitus, peripheral vascular diseases, carpal tunnel operation in the past, certain medication. The non-exposed must have worked during at least 2 years, the exposed had to reach a score of at least 40.

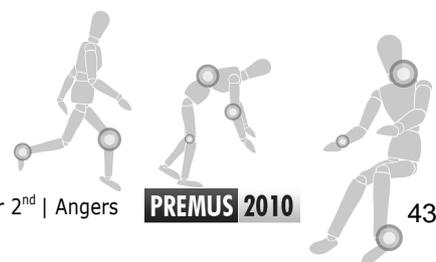
### Results:

1. There is a statistically significant difference in Sensibility Index between the exposed and the non exposed group ( $p < 0,05$  for each finger);
2. There is a statistically significant correlation ( $p < 0,05$  for all fingers) between the information obtained anamnestically (neurological staging with Stockholm Workshop Scale) and the Sensibility Index: the lower the SI-index, the more chance on finding a neurological staging of  $\geq 1$ ;
3. There is a clear trend of diminishing Sensibility Index with increasing exposure. A exposure score of 400 and more seems to be an important parameter to define the risk for neurological disturbances ( $p < 0,001$  for 3 fingers and 0,004 for the 4th finger).

### Conclusion:

1. The Vibrosense® is a reliable instrument for screening of neurological disturbances and follow-up of the evolution of HAV-syndrome.
2. Selection of workers with presumed lesions or at risk can easily be done by calculation the score of exposure (hours/week x years exposed).
3. The Stockholm Workshop Scale is an important instrument in criticizing the chance on finding neurological damage due to hand-arm vibrations.

**Keywords:** Exposure measurement methods, upper limb, other



## PSYCHOMETRIC EVALUATION OF THE QUESTIONNAIRE "THE PAIN DISABILITY QUESTIONNAIRE - PDQ" – BRAZILIAN PORTUGUESE VERSION

GIORDANO P.C.M., ALEXANDRE N.M.C.

Faculty of Medical Sciences, State University of Campinas - UNICAMP

### Aims:

The objective of the present research project was to translate and adapt "The Pain Disability Questionnaire" into Brazilian Portuguese, in order to assess its psychometric properties and to verify its usability.

### Methods:

Methodological steps recommended by specialized publications were followed in order to ensure the quality of adaptation: translation, back-translation, synthesis, evaluation by a committee of judges, and a pre-test with 30 patients. The psychometric properties were assessed by applying the questionnaire to 119 patients with chronic musculoskeletal disorders. Reliability was verified by internal consistency and test-retest stability. The validity was obtained through correlation analyses of the Pain Disability Questionnaire scores with the numerical pain scale and with the Spitzer Quality of Life Index (QLI). The validity was verified using the known-groups technique, administering the questionnaire both to a group with chronic musculoskeletal disorders and to a group with no disabilities. The instrument's usability was assessed using a five-point Likert scale, addressing time spent and facility in answering.

### Results:

The results indicate the instrument's reliability, with a Cronbach's Alpha Coefficient of 0.86. Test-retest results showed a high intraclass correlation: ICC=0.95 ( $p < 0.001$ , 95% CI: 0.93, 0.96). A moderate positive correlation ( $r = 0.33$ ) was found between the scores of the Pain Disability Questionnaire and the numerical pain scale. Statistically significant negative correlations were found with the Pain Disability Questionnaire Total ( $r = -0.70$ ), the Functional Condition ( $r = -0.63$ ), and the Psychosocial Component ( $r = -0.69$ ) as correlated with the Spitzer Quality of Life Index (QLI). In assessing validity using the known-groups technique, a statistically significant difference was found in scores of the PDQ between subjects with musculoskeletal symptoms and individuals with no disability. The usability evaluation showed rapid application and ease of understanding on the part of subjects of the study.

### Conclusion:

The results indicate that the cross-cultural adaptation process was successful and that the adapted version offers reliable and valid psychometric measures in the Brazilian context.

**Keywords:** Pain, chronic pain, Specific health outcomes, Other

### References:

- Anagnostis C, Gatchel RJ, Mayer TG. The pain disability questionnaire: a new psychometrically sound measure for chronic musculoskeletal disorders. *Spine*. 2004;29(20):2290-302.
- American Academy of Orthopaedic Surgeons Institute for Work Health. Recommendations for the cross-cultural adaptation of health status measures. Canada; 2002.
- Beaton DE, Bombardier D, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine*. 2000;25(24):3186-91. .



## OPEN VERSUS ENDOSCOPIC CARPAL TUNNEL RELEASE: USING QUICKDASH (A SHORTENED DISABILITIES OF THE ARM-SHOULDER-HAND QUESTIONNAIRE) IN BOUCHES-DU-RHÔNE, FRANCE, APRIL 2008 TO DECEMBER 2009 (PRELIMINARY RESULTS)

BACKX A.<sup>1,3</sup>, SILLAM F.<sup>2</sup>, HA C.<sup>2</sup>

<sup>1</sup> CIRE Sud (South Interregional Cell for Epidemiology of InVS), Rue Borde 23-25, CEDEX 8, Marseille, France - <sup>2</sup> Occupational Health Department, InVS (French Institute for Public Health Surveillance), St. Maurice, France - <sup>3</sup> Fellow of the European P

### Aims:

Carpal Tunnel Syndrome (CTS) is a common condition and often related to work or strain. Surgical release of the median nerve at the carpal tunnel is indicated in severe cases of CTS and/or after conservative treatment fails. The main surgical techniques are the open carpal tunnel release (OCTR) or the endoscopic carpal tunnel release (ECTR). This study was conducted to compare the effectiveness of four techniques, i.e. classical open (OCTR), 'mini-open' (OCTRm), Agee (ECTR) and a 'variation' (ECTRv) in the general population of working age (20-64) in the French region Bouches-du-Rhône.

### Methods:

A prospective cohort study was conducted between April 2008 and December 2009 using the QuickDASH (QD) [1] to quantify, by scores ranging from 0 (no functional constraints) to 100 (severe functional constraints), self-rated treatment effectiveness at six months after surgery. The preoperative-to-postoperative changes in QD-scores were assessed statistically (T-test) and change-detection measures (effect size (ES), standardized response mean (SRM)) calculated for each of the surgical methods.

### Results:

A total of 975 patients were included in the cohort, of whom 886 were eligible for analysis. Of these 886 patients, 681 were female with a mean age of 49 (23-64) and 205 were male with a mean age of 50 (21-65). The mean QD-scores for the total population show a statistical improvement between pre and postoperative scores (p0.05).

However, comparing the two most frequently used techniques OCTRm (n=510, F=400, M=110) and ECTR (n=265, F=197, M=68), revealed a difference in distribution of patients by age (p

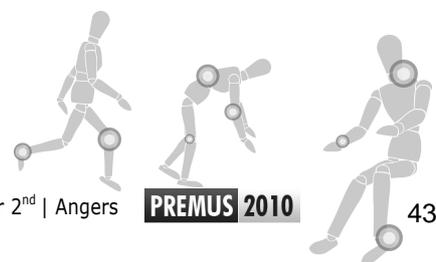
### Conclusion:

The QuickDASH was able to detect a mean amelioration in all four techniques six months after surgery. However, the distribution of patients over the techniques differed statistically for several variables, like age, body-mass-index and surgical team. The choice for a surgical technique appears to be highly dependable of surgical team and surgery room, which might indicate that personal preferences, experience of surgeons and equipment of surgery rooms play a major role in the choice of a carpal tunnel release technique. This finding is in agreement with previous studies [2]. Multivariate analysis is ongoing in order to detect which variables play predominant roles in effectiveness of the surgical techniques.

**Keywords:** Epidemiology, carpal tunnel syndrome, specific health outcomes

### References:

- [1] Haduk P.J., Amadio P.C., Bombardier C., and Upper Extremity Collaborative Group, Development of an upper extremity outcome measure: the DASH (Disabilities of the Arm, Shoulder, and Hand). American journal of industrial medicine. 1996;29:602-608,
- [2] Scholten R.J., Mink van der Molen A., Uitdehaag B.M., Bouter L.M., de Vet H.C., Surgical treatment options for carpal tunnel syndrome. Cochrane.Database. Syst.Rev. 2007;4:CD003905



## PERMANENCE OF MUSCULOSKELETAL DISORDERS AT CONSTRUCTION WORKERS – A FOLLOW-UP

HARTMANN B., SEIDEL D.

*Permanence of Musculoskeletal Disorders at Construction Workers – a follow-up*

### Aims:

Musculoskeletal disorders of construction workers are very important for their work ability. Preventive health examinations should help to find out these disorders early. It is unknown how permanent the findings are if they are ascertained by occupational physicians. The results from occupational health examinations of construction workers which were investigated twice or more shall help to clear the permanence of findings.

### Methods:

Between 1991 and 2003 data from preventive health examinations of 170.479 male construction workers were saved. 37.928 persons have at least two examinations. The mean distance is 4.4 (younger people) to 3.5 years (older >45 years). Comparisons between two times were analyzed about the permanence of complaints and findings.

### Results:

From people with back pain 45% of the age >45 years (age at first examination) suffer by this in both examinations, from joint pain >29%. The permanence of clinical findings is between 25% (muscular hardness in cervical or lumbar back) and 16% (wrist).

The remaining persons have findings only at the first or the second examination. Altogether only 4% of the elder people have permanent functional findings in the lumbar region, but 19% changing with time (picture 1).

People who have >1 examination show nearly the same frequency of back or joint pain than people with one examination. Workers with cardiovascular complaints or medical treatment often don't come one more to the preventive health examination.

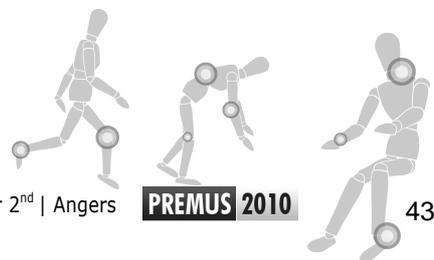
### Conclusion:

There are quite few permanent findings with functional restrictions at the musculoskeletal system. The reasons could be the less standardized methods of clinical examination at the musculoskeletal system too. Relevant amount of complaints and findings is not permanent in the same grade. Particularly older construction worker suppress findings because they have bad chances to find a job with lower physical demands.

**Keywords:** Construction, Epidemiology, Prognosis of MSD

### References:

Bildt Thorbjörnsson CA et al. (1998): Psychosocial and physical risk factors associated with low back pain: a 24 year follow up among women and men in a broad range of occupations. *Occup Environ Med* 55: 84 – 90.  
Arndt V et al. (2005): Construction work and risk of occupational disability: a ten year follow up of 14 474 male workers. *Occup Environ Med* 62: 559 – 566.



## LUMBAR BONE MASS PREDICTS LOW BACK PAIN IN MALES

HOOZEMANS M.J.M.<sup>1</sup>, KOPPE L.L.J.<sup>3</sup>, TWISK J.W.R.<sup>2</sup>, VAN DIEËN J.H.<sup>1</sup>

<sup>1</sup> Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands. – <sup>2</sup> Institute for Research in Extramural Medicine (EMGO), VU University Medical Center, Amsterdam, The Netherlands. - <sup>3</sup> TNO Quality of Life, Hoofddorp, The Netherlands

### Aims:

Results of clinical and in vitro studies indicate that a fracture of the vertebral endplate, caused by compression forces, may be a primary cause of (non-specific) low back pain (LBP) (1). A logical inference from this hypothetical causative mechanism is that the compressive strength of (lumbar) vertebrae, approximated by bone mineral content (BMC) and bone mineral density (BMD), would be a determinant of LBP. The objective of the study was to investigate whether low BMC and BMD values at the age of 36 years are related to the prevalence of LBP at the age of 42 years among the study population of the Amsterdam Growth and Health Longitudinal Study.

### Methods:

At the age of 36 years the lumbar BMC and BMD was determined by dual-energy x-ray absorptiometry (DEXA) in 140 males and 152 females. At the age of 42 years the participants were asked whether they had experienced LBP in the previous twelve months. Logistic regression analyses were performed to determine the relationship between BMC/BMD and LBP, adjusted for stature, bodyweight and physical activity.

### Results:

BMC and BMD at the age of 36 years were significantly related to the reported 12-month prevalence of LBP at the age of 42 years. This relationship was only observed for males and not for females. Men within the quartile with the lowest BMC or BMD values had significant adjusted OR's for LBP of 4.21 (95% CI: 1.36-13.0) and 3.14 (95% CI: 1.12-8.82) respectively, with the quartile with the highest BMC or BMD values taken as reference.

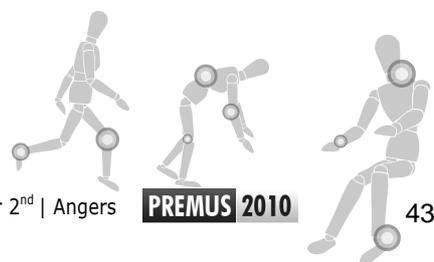
### Conclusion:

In conclusion, for a male population that is not characterised by osteoporosis or old age, lower lumbar BMC and BMD values are associated with a higher risk of reporting LBP in the future. Combined with the relationship between physical activity and bone mass (2), these findings support physical activity, in particular weight-bearing activity, as a preventive measure to decrease the risk of developing LBP.

**Keywords:** Biomechanics, Epidemiology, Back, Low back

### References:

Van Dieën JH, Weinans H, Toussaint HM. Fractures of the lumbar vertebral endplate in the etiology of low back pain. A hypothesis on the causative role of spinal compression in a-specific low back pain. *Medical Hypotheses*. 1999;53(3):246-52.  
Bakker I, Twisk JW, Van Mechelen W, Roos JC, Kemper HC. Ten-year longitudinal relationship between physical activity and lumbar bone mass in (young) adults. *J Bone Miner Res*. 2003;18(2):325-32.



## PAIN ATTENUATION AND ITS RELATIONSHIP TO FUNCTION IN A LONGITUDINAL LOW BACK PAIN COHORT

MCGORRY R.W., SHAW W.S., LIN J.H.

*Liberty Mutual Research Institute for Safety, Hopkinton, MASSACHUSETTS, USA*

### Aims:

The relationship between LBP and perceived functional limitation has significant implications for rehabilitation. Most studies of this association have been cross-sectional, and most have shown only modest correlations between reports of pain and function. Though functional limitation may be a superior measure for predicting disability outcomes, there is a continued need to understand the gap between pain and function. The study aim was to analyze changes in intra-individual correlations between pain and function over time and in relation to pain history.

### Methods:

Seventeen men and 16 women (ages 18 – 65) currently experiencing LBP were recruited. Self-reports of LBP using a 0-to-10 rating scale and functional status using the Back Pain Functional Scale (Stratford et al., 2000) were collected for up to eight visits over a period of eight weeks. Correlation coefficients between pain and function scores were calculated for each individual over the study period. The effect of pain history (transient vs. chronic), pain intensity, and variability of pain symptoms, on pain-function correlations were assessed. T-tests evaluated differences between participants groups for the above variables, and one-way ANOVA for gender and age.

### Results:

There were no significant differences in pain-function correlation due to gender, age, or pain intensity (low vs. high). Participants with a larger range in pain scores over the study period ( $\geq 4$  points) had significantly stronger relationships between pain and function,  $r = -0.82$  and  $r = -0.52$ , respectively. Likewise, when participants had at least one pain-free score during the reporting period, they had significantly stronger correlations than those with no pain-free reports,  $r = -0.80$  and  $r = -0.50$ , respectively. When classified by the criteria proposed by Von Korff (1994) participants having transient LBP had stronger correlations ( $r = -0.83$ ) than those who experienced more chronic LBP ( $r = -0.62$ ).

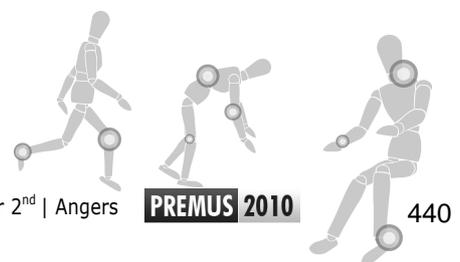
### Conclusion:

The results of this study suggest that within-person correlations between pain and functional limitation over the course of LBP are much stronger than those reported in cross-sectional, population-based studies. Therefore, changes in ratings of pain intensity over time may have more clinical relevance than the different pain levels between patients. Age and gender did not influence the within-person association between pain and function. Among those with a more longstanding pain problem, factors other than pain intensity (e.g., pain catastrophizing, fear avoidant beliefs) may have a greater effect on day-to-day perceptions of functional limitation.

**Keywords:** Psychosocial factors, Disability prevention, Back, Low back

### References:

Stratford PW, Binkley JM, Riddle DL. Development and initial validation of the back pain functional scale. *Spine*. 2000;25:2095-102.  
Von Korff M. Studying the natural history of back pain. *Spine*. 1994;19(18 Suppl):2041S-46S.



## HIGH NEED FOR RECOVERY AND ABSENCES FOR MUSCULOSKELETAL DISORDERS

MORIGUCHI C.S., ALEM M.E.R., VAN VELDHOVEN M., GIL COURY H.J.C.

*Laboratory of Ergonomics, Physiotherapy Department, Federal University of São Carlos, São Carlos, São Paulo State, Brazil.*

### Aims:

The Need for Recovery (NFR) scale evaluates work-induced fatigue and the quality of worker recovery by the assessment of severity and duration of fatigue symptoms<sup>1</sup>. Previous studies have revealed that NFR predicts sickness absence among truck drivers<sup>2</sup>. Thus, the aim of this study was to verify if high levels of need for recovery evaluated by the Brazilian version of the Need for Recovery Scale<sup>3</sup> were associated with sickness absence related to musculoskeletal disorders among workers from a wood manufacturing industry.

### Methods:

One hundred and fifty industrial workers (110 women and 40 men; mean age of  $34.2 \pm 8.2$  years) answered the NFR scale. The sickness absence data for these workers were provided by the company Occupational Health Section. Only absences related to musculoskeletal disorders were considered. The absences were recorded from the month after the NFR assessment (August, 2008) till December, 2009. The periods of absence were split into two categories: short periods (up to 15 days) and long periods (more than 15 days). The absences lasting more than 15 days are controlled by the National Security Insurance. Data were analysed descriptively.

### Results:

Of the workers studied, 26 presented short periods of absence with a mean NFR score of  $42.3 \pm 15.2$ . Only 4 workers presented periods of absence longer than 15 days. For these workers a mean NFS score of  $65.2 \pm 10.4$  was identified. Workers with no absenteeism whatsoever revealed a mean NFS score of  $43.0 \pm 17.8$ .

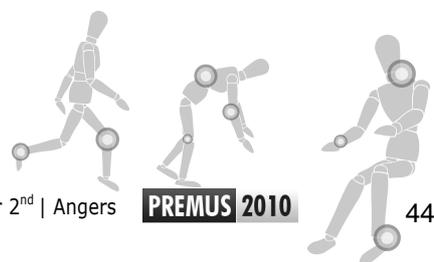
### Conclusion:

Although the number of workers presenting longer periods of absence from work was small, consistent higher levels of NFR scores were associated for all the workers in this group (scores  $>45$ ). These results are in accordance with earlier studies using the NFR scale in other countries<sup>2</sup>, indicating that the NFR scale can be an important tool for early detection of serious musculoskeletal disorders among industrial workers.

**Keywords:** Specific sectors, Early prevention, Disability prevention

### References:

- Van Veldhoven M, Broersen S. Measurement quality and validity of the "need for recovery scale". *Occup Environ Med.* 2003;60(Suppl 1):i3-i9.
- De Croon EM, Sluiter JK, Frings-Dresen MHW. Need for recovery after work predicts sickness absence. A 2-year prospective cohort study in truck drivers. *J Psychosom Res* 2003;55:331-9.
- Moriguchi CS, Alem MER, van Veldhoven M, Gil Coury HJC. Cultural adaptation and psychometric properties of Brazilian Need for Recovery Scale. *Rev Saúde Pública.* In Press.



## PROFILE OF THE SAO FRANCISCO UNIVERSITY EMPLOYEES ACCOMPLISHED PHYSIOTHERAPY SERVICE IN OCCUPATIONAL HEALTH AND ERGONOMICS

PADULA R.S.<sup>1,2</sup>, LIMA,L.B.<sup>1</sup>, LIMA N.<sup>1</sup>

<sup>1</sup> Universidade Sao Francisco (USF) - <sup>2</sup> Universidade Cidade de São Paulo, Brazil

### Aims:

Describe the profile of employees evaluated in the physiotherapy service in occupational health and ergonomics between 2005 to 2009

### Methods:

Were used to search the files of identification, history of complaints, physical examination, registration procedures for promotion and prevention carried out by professionals of the Physiotherapy in Occupational Health and Ergonomics. The information were collected from Nordic Musculoskeletal Questionnaire.

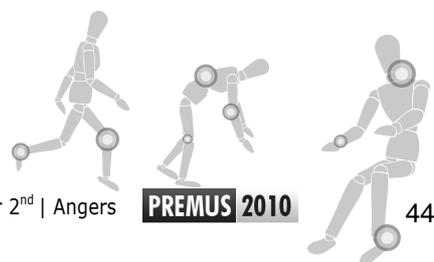
### Results:

The employees arrived at the assessed service Occupational Physiotherapy and Ergonomics by spontaneous demand. The goal was to identify musculoskeletal symptoms since the beginning to avoid the aggravation. We evaluated 198 workers between 2005 and 2009, the information are Table 1. The total employees evaluated 82% were female and 18% male, 42% had aged 20 to 30 years, 29% between 30 and 40 years and 29% over 40 years. 51% of employees are over 10 years in the same task. Since had been 69% of employees were some kind of musculoskeletal symptoms, with 48% de lombar, 21% thoracic spine, 14% cervical spine, and 17% upper limb. During the 5 years of the actions of health promotion and disease prevention and 48% of employees reported that musculoskeletal symptoms were stable, 39% decreased to 13% increased.

### Conclusion:

The labor exercises and educational guidelines were introduced since 2005 and the employees were reassessed every six months to monitoring of symptoms. The actions of promotion and prevention must have been responsible for the reduction and stability of symptoms. The results show that in 2007 was rated a greater number of employees compared to other years this can be explained because implemented a quick massage, and so that employees could participate should be doing all the activities of the program. The conclusion of this study is that early diagnosis of musculoskeletal symptoms contributes to the control the risks.

**Keywords:** Specific sectors, epidemiology, disability prevention



## SICK LEAVES IN THE TWO YEARS FOLLOWING INTERVENTION FOR LOW BACK PAIN: A RANDOMIZED CONTROLLED STUDY COMPARING MULTIDISCIPLINARY FUNCTIONAL RESTORATION AND AMBULATORY PHYSIOTHERAPY

ROCHE-LEBOUCHER G., BONTOUX L., DUBUS V., PETIT LE MANAC'H A., RICHARD I.

LEEST, University of Angers, France

### Aims:

Functional restoration programs (FRP) are recommended in chronic low back pain, but are only available for a limited number of patients. The aim of this study is to compare the results on return to work, of an intensive out-patient functional rehabilitation program and of an ambulatory program consisting in three sessions of active individual therapy (AIT) per week during five weeks

### Methods:

Design: Prospective randomized controlled study.

Patients: 132 adult patients suffering from non specific low back pain, on sick-leave or facing significant work disability.

Intervention: Functional rehabilitation program (multidisciplinary intervention including physiotherapy, occupational therapy, psychological counseling and coordination with occupational medicine facilities : 150 hours in a rehabilitation centre) or Active individual therapy (15 hours supervised by private practice physiotherapists).

Main outcome measure: Number of days of sick-leave in the two years following the program  
Secondary outcome measures : trunk flexibility, back flexor and extensor endurance (Ito and Sorensen tests), general endurance, pain intensity, Dallas Pain Questionnaire (DPQ) scores (on daily activities, anxiety depression, social interest, and work and leisure activities)at the end of the program and at two years.

### Results:

Fifty-one percent of patients were on sick leave before treatment (mean duration, 180 days in the 2 years before treatment). All outcome measures improved after treatment, except endurance in AIT. At two years follow-up, 15 patients (11.3%) were lost to follow up; all physical criteria (except endurance) were better than before treatment without difference between groups; pain intensity was improved only in FRP; DPQ scores were improved only on daily activities and work and leisure activities, with better results on WL in FRP. The number of days of sick leave in the two years after treatment was significantly improved, with no difference between groups (73.5 days in AIT versus 53.5 in FRP,  $p=0.45$ ).

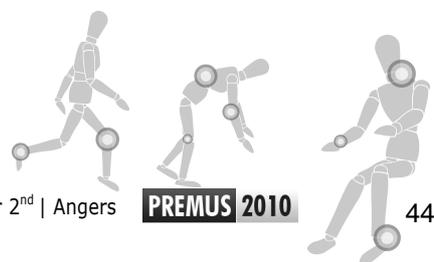
### Conclusion:

AIT shows good results and could be sufficient for a large proportion of patients, but further studies are necessary to precise orientation criteria between the two therapies.

**Keywords:** Intervention studies, return to work, back, low back

### References:

Jousset N, Fanello S, Bontoux L, et al. Effects of functional restoration versus 3 hours per week physical therapy: a randomized controlled study. *Spine* 2004;29:487-93; discussion 494.,  
Roche G, Ponthieux A, Parot-Shinkel E, et al. Comparison of a functional restoration program with active individual physical therapy for patients with chronic low back pain: a randomized controlled trial. *Arch Phys Med Rehab*. 2007;88(10):1229-35.



## EFFECTIVENESS OF A NEW SEQUENCED MULTI-DISCIPLINARY REHABILITATION PROTOCOL FOR THORACIC OUTLET SYNDROME IN INDIAN COMPUTER PROFESSIONALS

MOHAN BABU R., SHARAN D., RAMESHKUMAR R., AJEESH P.S.

*Recoup neuromusculoskeletal rehabilitation centre, Bangalore, India*

### Aims:

The purpose of this study was to determine the effectiveness of a new sequenced, multi-disciplinary rehabilitation protocol in reducing pain, numbness, and other disabling symptoms of Thoracic Outlet Syndrome (TOS), a common work related neuromusculoskeletal disorder in computer professionals.

### Methods:

Hundred consecutive computer professionals working full time in IT Companies in Bangalore (India) diagnosed to have TOS based on a physical examination by a physician were included in the study. The criteria for diagnosis (Gillard, et al, 2001) included positive findings from five provocative tests involving Adson's test, Wright's test considered positive if symptoms reproduced, Wright's test considered positive if radial pulse abolished, Hyperabduction test considered positive if radial pulse abolished, Roos test and Tinel's test. The interventions included deep pressure soft tissue massage, myofascial release, neural and soft tissue mobilization, first rib and shoulder girdle mobilization, mind body methods (yoga, cognitive behavioral therapy), strengthening, aerobic conditioning, postural training and work station modification in a sequence.

### Results:

Fifty six patients were male and the median age was  $31.25 \pm 5.75$  years. The commonest symptoms were pain (76%), numbness (69%), weakness (67%) and paraesthesiae (62%). Pre and post treatment outcome was measured using Numerical Pain Scale (NPDVAS), Neck Disability Index (NDI), Pressure Algometry (Wagner) and Cervical Range of Motion (CROM) Instrument. The post treatment outcome measurement took place at the end of 2 and 4 weeks. Mixed analyses of variance with follow-up evaluation showed a significant difference for all outcome measures following the treatment. After an average of 4 week of intervention, patients demonstrated statistically significant improvement in NPDVAS (68.8%,  $t=30.285$ ;  $P<0.001$ ), NDI (59.1%,  $t=32.978$ ;  $P<0.001$ ), Algometry ( $3.41 \pm 0.41$ ,  $<0.001$ ) and CROM (Significance:  $<0.001$ ).

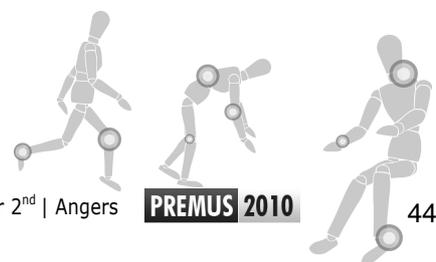
### Conclusion:

The described rehabilitation protocol was uniformly successful in relieving symptoms and restoring computer professionals with TOS to their previous function and work intensity.

**Keywords:** Upper limb, prognosis of MSD, specific health outcomes

### References:

1. Gillard J, Pérez-Cousin M, Hachulla E, Remy J, Hurtevent JF, Vinckier L, Thévenon A, Duquesnoy B. Diagnosing thoracic outlet syndrome: contribution of provocative tests, ultrasonography, electrophysiology, and helical computed tomography in 48 patients. *Joint Bone Spine*. 2001 Oct; 68(5): 416-24.
2. Vanti C, Natalini L, Romeo A, Tosarelli D, Pillastrini P. Conservative treatment of thoracic outlet syndrome. A review of the literature. *Eura Medicophys*. 2007 Mar; 43(1): 55-70.
3. Crosby CA, Wehbé MA. Conservative treatment for thoracic outlet syndrome. *Hand Clin*. 2004 Feb;20(1):43-9



## PREDICTING INJURED WORKERS' EXPERIENCE OF "ABSENTEEISM ↔ AT-WORK PRODUCTIVITY LOSS" OVER ONE YEAR AFTER WSIB SPECIALTY CLINIC ATTENDANCE

BEATON D.E., JIANG D., TANG K., MACDERMID J., RICHARDS R.R., FRANCHE R.L., CÔTÉ P., HOGG-JOHNSON S., BOMBARDIER C.

*Institute for Work & Health, Toronto, Ontario, Canada; St. Michael's Hospital, Toronto, Ontario, Canada; McMaster University, Hamilton, Ontario, Canada; Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada.*

### Aims:

Health- and work-related factors associated with more successful work outcomes (less work absenteeism and presenteeism) are unclear for injured workers (IWs) attending a Workplace Safety & Insurance Board (WSIB) Shoulder and Elbow Specialty clinic [1] in Ontario, Canada. Our aim is to develop a prognostic profiling system for clinic attenders and to evaluate its ability to predict work disability outcomes one year after Specialty clinic attendance.

### Methods:

IWs recruited by convenience sampling (n=614) were followed for four time-points over one year (baseline and follow-up at 3, 6, and 12-month). A latent class analysis was initially performed to characterize IWs based on relevant disease-related, sociodemographic, workplace or job characteristic variables collected at baseline (i.e. demonstrating  $p < 0.05$  during bivariate analysis). Prognostic clusters determined from the latent class analysis were then examined for the ability to predict a reduction in both work absenteeism (decreased probability of working) and presenteeism (decreased at-work productivity loss measured by the Work Limitations Questionnaire [WLQ] Index [2], range: 0–28.6, 28.6=most productivity loss at work) using a two-part (logistic/linear) growth modeling approach [3] based on structural equation modeling.

### Results:

A 4-cluster model based on 16 key factors (8 disorder-related and 8 workplace/job-related variables) was found to best describe the prognostic characteristics of IWs. By this approach, workers were classified into one of the following groups: "low pain/disability, high support" (26.5%), "low pain/disability, low support" (17.8%), "high pain/disability, high support" (36.0%), or "high pain/disability, low support" (19.7%). Compared to the latter group (as reference), membership in any of the former three groups predicted a significantly greater likelihood of remaining/returning to work (OR range = 2.5 – 13.9,  $p$

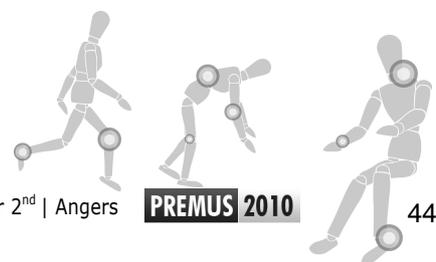
### Conclusion:

Current results demonstrated the ability of a novel and comprehensive prognostic classification system to concurrently predict both work absenteeism and presenteeism outcomes in IWs recovering from upper-limb disorders, within a single analytic model. Application of this system at the WSIB Specialty clinics may have the potential to help clinicians and IWs better understand and negotiate recovery expectations, and to help target workers at especially high risk for less successful work outcomes.

**Keywords:** Methods in epidemiology, Return to work, Upper limb.

### References:

- [1] Workplace Safety Insurance Board (WSIB) of Ontario. Shoulder and Elbow Program. Information available from (accessed October 2009): <http://www.wsib.on.ca/wsib/wsibsite.nsf/Public/HealthSpecialtyShoulderElbow>
- [2] Lerner D, Amick BC, 3rd, Rogers WH, Malspeis S, Bungay K, Cynn D. The Work Limitations Questionnaire. *Med Care*. 2001;39:72-85.
- [3] Olsen MK, & Schafer JL. A two-part random effects model for semicontinuous longitudinal data. *J Amer Statistical Assoc*. 2001;96:730-745.



## **“WORK INSTABILITY” PREDICTS GREATER WORK DISABILITY AND DOWNWARD TRANSITIONS IN WORK STATUS FOR INJURED WORKERS WITH UPPER-LIMB DISORDERS AFTER ONE-YEAR ATTENDANCE AT A WSIB SPECIALTY CLINIC**

TANG K., BEATON D.E., GIGNAC M.A.M., BOMBARDIER C.

St. Michael's Hospital, Toronto, Ontario, Canada; Institute for Work & Health, Toronto, Ontario, Canada; Toronto Western Hospital, Toronto, Ontario, Canada.

### **Aims:**

The 23-item Work Instability Scale (WIS), originally developed for rheumatoid arthritis, assesses the extent of mismatch between worker abilities and work demands – a concept known as “work instability”. Recent evidence supports the reliability and validity of the WIS for injured workers (IWs) with upper-limb disorders (1). Our aim is to examine whether “work instability” is predictive of greater work disability experienced by IWs following one-year attendance at a Shoulder and Elbow Specialty clinic (2) operated by the Workplace Safety & Insurance Board (WSIB) in Ontario, Canada.

### **Methods:**

IWs who were working upon initial clinic attendance (baseline, n=316) were followed at 3, 6, and 12 months. At baseline, data for the WIS (range: 0-23, 23=highest work instability) and a total of 34 disorder-related, sociodemographic, workplace, or job characteristic factors were collected. Work outcomes assessed at all timepoints include work status (working: Y/N, full duties/modified duties/reduced hours) and at-work productivity loss measured by the Work Limitations Questionnaire (3) (WLQ Index, range: 0–28.6, 28.6=highest at-work productivity loss; equivalent to 25% productivity loss compared to a healthy worker). Multivariable logistic regressions were conducted to determine prognostic factors ( $p < 0.05$ ) associated with: (A) greater at-work productivity loss after one year, using a novel approach that combines work status and WLQ scores into a four-level ordinal outcome, or (B) a “downward” transition in work status (full duties > modified duties/reduced hours > not working) occurring between study timepoints.

### **Results:**

After one year, 20%, 39%, and 10% of the sample were working at <5%, 5-15%, and 15-25% productivity loss, respectively, based on WLQ Index scores. 31% of the IWs were not working. Over the course of the study, 46% had transitioned from working full duties to working modified duties or reduced hours, while 43% had transitioned to not-working. Higher baseline WIS score was predictive of greater work productivity loss (adjusted OR [95%CI] = 1.15 [1.07-1.23],  $p < 0.001$ ), as well as an impending downward transition in work status (adjusted OR [95%CI] = 1.09 [1.02-1.17],  $p < 0.01$ ). Less supportive organizational policies on workplace safety and disability management (i.e. lower score on the Organizational Policies & Practices scale) was also revealed as an important factor ( $p < 0.07$ ) associated with less favorable outcomes.

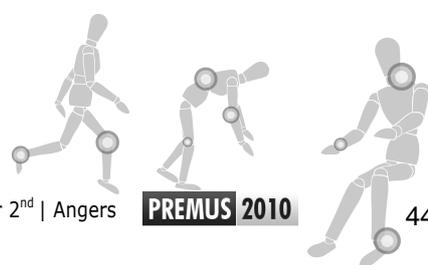
### **Conclusion:**

Current results demonstrated the predictive ability of the WIS for greater work disability based on two outcomes that are meaningful to IWs, employers, clinicians and the WSIB. High “work instability” is emerging as a relevant prognostic factor for less favorable work disability outcomes associated with work-related upper-limb disorders.

**Keywords:** Epidemiology, Upper limb, Specific health outcomes

### **References:**

- Tang K, Pitts S, Solway S, Beaton, D. Comparison of the psychometric properties of four at-work disability measures in workers with shoulder or elbow disorders. *J Occup Rehabil.* 2009;19:142-54.
- Workplace Safety Insurance Board (WSIB) of Ontario. Shoulder and Elbow Program. Information available from (accessed October 2009): <http://www.wsib.on.ca/wsib/wsibsite.nsf/Public/HealthSpecialtyShoulderElbow>
- Lerner D, Amick BC, 3rd, Rogers WH, Malspeis S, Bungay K, Cynn D. The Work Limitations Questionnaire. *Med Care.* 2001;39:72-85.



## CAN INTERNATIONALLY RECOMMENDED OUTCOME DOMAINS CAPTURE ASPECTS THAT ARE PROMINENT FOR THE HEALTH EXPERIENCES OF WOMEN WITH NECK- AND SHOULDER PAIN? - A FACTOR ANALYSIS.

WIITAVAARA B.<sup>1</sup>, BJÖRKLUND M.<sup>1,2</sup>, DJUPSJÖBACKA M.<sup>1</sup>, NILSSON A.<sup>3,4</sup>

<sup>1</sup> Centre for Musculoskeletal Research, University of Gävle, Gävle, Sweden - <sup>2</sup> Alfta Research Foundation, Alfta, Sweden - <sup>3</sup> Department of Caring Sciences and Sociology, University of Gävle, Gävle, Sweden - <sup>4</sup> Department of Caring Sciences, Uppsala University, Uppsala, Sweden

### Aims:

The aim was to determine prominent health aspects that require assessment among women with non-specific neck-shoulder disorders.

### Methods:

This cross-sectional study is based on data from a clinical RCT-study of neck-shoulder treatment (ISRCTN92199001). Participants were 122 women, 18-64 years, with non-specific neck-shoulder pain >3 months. Data collection was based on international recommendations made by the "Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials" (IMMPACT) [1]. Three core domains; pain intensity, physical- and emotional functioning, were measured using: the Multidimensional Pain Inventory (MPI-S), Montgomery-Åsberg Depression Scale (MADRS-S), and Ryff's Psychological Well-being Scale (RPWS, 18 items). The analysis was performed in several steps, using PCA with orthogonal varimax rotation and two subsamples (n=106), drawn from the original sample (N=117).

### Results:

The preliminary results suggest an eight factor solution including items loading > .50. The factor structure is quite coherent with the core domains recommended by IMMPACT, and also the original subscales of the included questionnaires. This can contribute to a reduced battery of questions which represent core dimensions for assessment among women with neck-shoulder disorders.

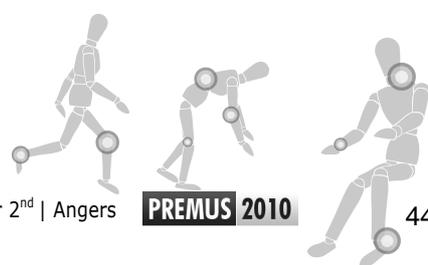
### Conclusion:

To decide on the effectiveness of specific treatments, the prospect of adequate comparisons is essential. As there is a lack of unity in choice of questionnaires today, as well as in included measures, further investigations of international recommendations regarding outcome measures are of interest. A reduced assessment battery that corresponds to the different aspects of health that is significant for a specific disorder would also lighten the assessment load in clinic as well as research. The preliminary results of present study indicate that the domains and measures suggested by IMMPACT may be relevant for this study group.

**Keywords:** Neck, pain, chronic pain, specific health outcomes

### Reference:

Dworkin, R.H., et al., Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. *J Pain*, 2008. 9(2): p. 105-21.



## RETURN TO WORK / TERTIARY PREVENTION

### DEVELOPING A GUIDE FOR MEASURING THE CONCEPT OF MARGIN OF MANOEUVRE

DURAND M.J., VÉZINA N., LOISEL P., RICHARD M.C.

*Centre for action in work disability prevention and rehabilitation (CAPRIT) and Université de Sherbrooke, Longueuil, Canada - Université du Québec à Montréal, Montréal, Canada - University Health Network and University of Toronto, Toronto, Canada*

#### Aims:

Currently, functional capacity evaluations focus solely on the match between work demands and workers' capacities. However, this does not take into account the variations in the person's health or condition, the work demands, or the interaction between the two. A new concept to help evaluate the complexity of work disability, adapted from the ergonomic field, was explored in a previous study: the margin of manoeuvre (MM) (Durand et al., 2009). The aim of the study is to develop a practical guide for clinicians to measure the indicators of the MM.

#### Methods:

The development of the guide will follow 5 steps: (1) sorting of indicators, (2) identification of tools and observation modes, (3) elaboration of initial version, (4) feasibility testing, and (5) final version of the guide. In this communication, we will present results from the first two steps. The 50 indicators identified in the previous study (Durand et al., 2009) were discussed with experts in work rehabilitation in order to combine those on similar concepts, clarify the terminology, and define each indicator. For each retained indicator, tools were searched in several databases, web search engines, and websites from research organization in the field of work disability.

#### Results:

A glossary was developed in order to define each indicator. Also, the indicators were classified based on the four types of MM (Durand et al, 2009): initial (MM available prior to work absence), potential (MM considered achievable by the end of the program), therapeutic (MM during the gradual work exposure), and final (MM at the end of the rehabilitation process). The most appropriate measurement tool for each indicator was chosen based on Rogers' characteristics of innovation (i.e., relative advantage, compatibility, complexity, triability, and observability) (Rogers, 2003). Indicators without a corresponding tool were discussed with clinical experts who described how they observed/evaluated them.

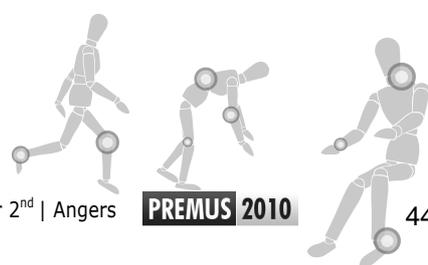
#### Conclusion:

The first steps of this study allowed the clarification of key indicators of the MM and identification of useful tools to help develop a practical guide for clinicians in work rehabilitation. These tools evaluate parameters from three main pole of the MM, i.e., personal parameters, work demands, and means/conditions offered by the workplace. Future challenge in this project will be to develop an easy-to-use, comprehensive guide that takes into account the multidimensional and dynamic character of the MM over time.

**Keywords:** Disability prevention, Return to work, Other

#### References:

Durand MJ, Vézina N, Baril R, Loisel P, Richard MC, Ngomo S. Margin of manoeuvre indicators in the workplace during the rehabilitation process: a qualitative analysis. *J Occup Rehabil.* 2009;19:194-202.  
Rogers EM. *Diffusion of innovation* (5th ed). New York: Free Press; 2003.



## EARLY INTERVENTION WITH LOW BACK INJURED WORKERS IN THE WORKERS' COMPENSATION CONTEXT

SCHULTZ Z., PRKACHIN K.M., CROOK J.M., BERKOWITZ J., MILNER R.

*University of British Columbia, Canada*

### **Aims:**

This study evaluated effectiveness of early intervention (EI) within compensation setting for back-injured workers, off work for 4-10 weeks and at moderate to high risk for high risk for disability. Objectives were: to evaluate RTW and economic EI outcomes; to compare fixed versus flexible EI delivery.

### **Methods:**

This randomized controlled study compared standardized, protocol-driven (fixed), interdisciplinary, multimodal case management-based early intervention (EI-1) for injured workers at two levels of risk (moderate, high) to flexible, individualized, clinically-driven intervention with same components (EI-2).

EI incorporated: clinical, occupational and case management; stakeholders' communication; workplace visit; motivational interviewing, RTW coaching by an occupational nurse; development of RTW plan. Risk status was determined by a validated questionnaire. Thirteen workers at high risk of disability and 16 workers at moderate risk received EI-1, and 11 workers assessed at high risk and 23 workers at moderate risk received EI-2.

Binary RTW outcomes were measured at three, six and twelve months and costs at six and twelve months.

### **Results:**

There was no difference between EI-1 or EI-2 for either risk category. For moderate risk, a higher percentage of EI-2 group returned to work by 3 months while for high risk, a higher percentage of EI-1 group returned to work by 3 months; neither difference was statistically significant. Overall, 93% of EI-1 group and 85% of EI-2 returned to work.

For high risk subgroup, a significantly higher percentage of EI-1 group returned to work by 6 months than for EI-2 group and Conventional Case Management group from pilot study (Schultz et al., 2008).

EI-1 group had twice as many interventions than EI-2 group and showed higher mean levels than EI-2 group for all cost variables, especially for moderate risk.

### **Conclusion:**

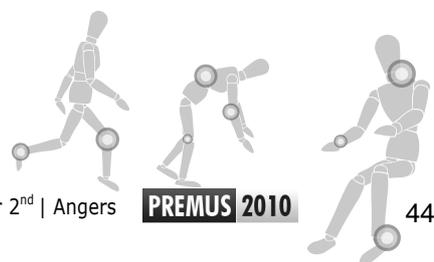
Multimodal EI in workers' compensation produces similarly high RTW outcomes both in standardized (fixed), protocol driven and in flexible format. Application of standardized protocol is more labour-intensive and costly compared to flexible delivery. Such costs are not justifiable for workers at moderate risk where fixed EI is redundant. Workers at moderate risk did better with flexible intervention, at lower cost. Consistent with pilot study (Schultz et al., 2008), RTW outcomes tend to support consideration of fixed protocol-driven EI, only for high risk workers.

Study results were limited by small sample sizes and generalizability issues.

**Keywords:** Intervention studies, Return to work, Back, low back.

### **References:**

Schultz I. Z., Crook J., Berkowitz, J., Milner, R., Meloche G. & Lewis, L. (2008). A prospective study of the effectiveness of early intervention with high risk back injured workers. *Journal of Occupational Rehabilitation*, 18(2), 140-151.



## COMPARATIVE STUDY ON THE USE OF KINESIOTHERAPY IN GROUPS AND INDIVIDUALLY ON PATIENTS WITH WORK-RELATED MUSCULOSKELETAL DISORDERS (WRMSD)

MENDES L.F.<sup>1</sup>, LANCMAN S.<sup>2</sup>

<sup>1</sup> Physiotherapy Program of the Methodist University of São Paulo, São Bernardo do Campo, Brazil - <sup>2</sup> Full Professor of the Department of Physiotherapy, Communication Science & Disorders, Occupational Therapy. Faculty of Medicine. Univer

### Aims:

This study compared the effects of individual and group kinesiotherapeutic treatment for WRMSD patients' pain conditions.

### Methods:

The study included 24 patients diagnosed with WRMSD randomly divided into two types of intervention: individual and group. The kinesiotherapy protocol was the same in both interventions and lasted 10 sessions. Each session offered a sequence of exercises and guidance based on techniques of self-stretching, muscle strengthening, joint mobilization, proprioceptive neuromuscular facilitation, postural re-education and breathing exercises. Individual sessions lasted 50 minutes and the group ones 90, this difference existing due to thematic discussions previously chosen to instigate reflection on important treatment aspects, which took longer in the group. The patients were evaluated individually in regards to pain before and after treatment. This evaluation was done through the VAS, which measured pain intensity at the beginning of each session and the McGill Pain Questionnaire. The VAS data was fitted to equation  $y = ax$ . The initial pain intensity was considered zero and was subtracted from all other values. The coefficients were compared using the X2 test, the remaining data was compared by the t-test with level of significance of 5%.

### Results:

The linear regression of pain intensity data measured by the VAS of patients undergoing group intervention resulted in a slope of  $-0.0061 \pm 0.0377$ , while for the other patients the slope was of  $-0.1928 \pm 0.0272$ . These coefficients were tested by the X2 test. It was observed that for patients in group treatment, the slope was not different from zero ( $p = 0.87$ ), indicating that this intervention has no effect on pain intensity. In individual intervention the slope was negative and different from zero ( $p = 0.0001$ ), indicating that this intervention induced pain reduction.

Qualitative analysis of pain symptoms through the McGill Pain Questionnaire revealed an increase in the total number of words used by patients to describe their painful conditions in both interventions. The comparison between the average of words used after treatment showed that patients undergoing group intervention used more descriptors and this difference is significant with  $p = 0.0005$ .

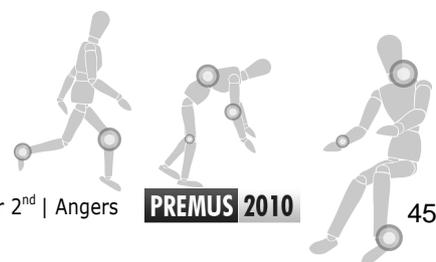
### Conclusion:

Individual and group kinesiotherapy helped the recovery and rehabilitation of patients with WRMSD. The group treatment produced a smaller improvement in pain intensity than the individual one, but increased the repertoire of words used to express the pain, resulting in a greater change in pain perception among participants.

**Keywords:** Disability prevention, Pain, chronic pain, Specific health outcomes

### References:

Nieuwenhuijsen K, Verbeek J H A M, Siemerink J C M J, Tummers-Nijssen D. Quality of rehabilitation among workers with adjustment disorders according to practice guidelines; a retrospective cohort study. *Occup. Environ. Med.* 2003; 60: 21-25.  
Konijnenberg HS, Wilde NS, Gerritsen AAM, van Tulder MW, de Vet HCW. Conservative Treatment for Repetitive Strain Injury. *Scand J Work Environ Health* 2001; 27: 299-310.



## EFFECTS OF A MULTIDISCIPLINARY INTERVENTION PROGRAM IN BACK AND NECK PAIN PATIENTS ABSENT FROM WORK- BASELINE DATA AND EFFECTS ON SUBJECTIVE WORKABILITY, LIFTING CAPACITY AND SICKNESS ABSENCE OVER 12 MONTHS

KLIPSTEIN A.<sup>1</sup>, LAEUBLI T.<sup>2</sup>, CANJUGA M.<sup>2</sup>, JORONEN H.<sup>1</sup>, NORBERG M.<sup>3</sup>, DANUSER B.<sup>4</sup>

<sup>1</sup> Dptm. Rheumatology and IPM, University Hospital - <sup>2</sup> ZOA, ETH, Zurich - <sup>3</sup> CHUV, Lausanne - <sup>4</sup> IST, Lausanne, Switzerland.

### Aims:

Sickness absence caused by back pain is a persistent and expensive health problem challenging most of industrial countries. Systematic reviews showed strong evidence, that multidisciplinary programs with a functional restoration approach including behavioural aspects and some relationship to the workplace improve function, but moderate evidence with respect to vocational outcomes. Furthermore, results depend on local (social) systems. Objective: to evaluate the effects of a multidisciplinary intervention on subjective workability, lifting capacity and the number of sick days.

### Methods:

The study design is a randomised, observer blinded, controlled trial (RCT) comparing a multidisciplinary intervention strategy with usual care/ attention at two sites - Lausanne and Zurich, Switzerland. 6 large sized companies took part in the study. Subjects with more than 20 (complete absence) or 60 (partial absence) days of absence from work because of chronic back or neck-shoulder pain were clinically evaluated for exclusion reasons (age >58, specific back- neck or shoulder disorder and any health condition not allowing a physical training). Subjects got a clinical baseline assessment including questionnaires performance tests and were randomized stratified by companies (intervention group or controls). Assessment was repeated 4 month after inclusion, absence days were continuously observed until 12 month after inclusion.

### Results:

n= 80 (61% male), n intervention= 46, controls= 34, average age of 45+/-8 y and absence duration of 68 +/- 34 days. Groups didn't differ by age, gender and absence duration at inclusion (Pr 0.90 to 0.99). Subjective workability (WAI) at baseline was in average 26.1 +/- 6.8 (intervention) respectively 23.8 +/-6.5 (controls, p>0.05), lifting capacity (lower PILE) 46.5 +/-9.5 kg (intervention) and 50.1 +/- 13.1 kg (controls, p>0.5). 2nd assessment 24 +/-6.7 weeks after inclusion in both groups with complete data in 46 subjects (61% male, 23 interventions and 23 controls). WAI at 2nd evaluation showed a statistically not significant trend to positive change over time in the intervention group with higher values already at start, but no change in PILE could be recognized.

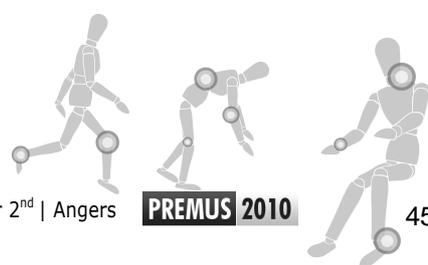
### Conclusion:

Due to the company based randomization procedure, more subjects were randomized to the intervention group by chance. Nevertheless, baseline data of groups were equal concerning age, gender and absence duration. WAI showed a positive trend over time in the intervention group. 12 month absence data are not completed yet due to the study process, but data of a large percentage will be available and analyzed at the congress.

**Keywords:** Disability prevention, Return to work, Back, Low back

### References:

Van Tulder M.W. Koes B. Malmivaara A. Outcome of non-invasive treatment modalities on back pain: an evidence-based review. Eur Spin J. 2006;15:64-81  
Läubli T. Bagdasarianz R. Klipstein A. Kern F. Canjuga M. Joronen H. Danuser B. Therapie für Rücken und Arbeitsplatz. Swiss Medical Forum / Schweizerisches Medizin-Forum.2008. 8(48):939-941.



## PHYSICAL CONDITIONING PROGRAMS FOR IMPROVING WORK OUTCOMES IN WORKERS WITH BACK PAIN: A COCHRANE SYSTEMATIC REVIEW

SCHAAF SMA F., SCHONSTEIN E., WHELAN K.M., ULVESTAD E., KENNY D.T., VERBEEK J.H.

*The University of Sydney, Australia*

### Aims:

This is an update of a Cochrane Review (Work conditioning, work hardening and functional restoration for workers with back and neck pain) first published in 2003.

The aim of this review was to compare the effectiveness of physical conditioning programs in reducing time lost from work and improving work status for workers with back pain.

### Methods:

We searched the following databases to June/July 2008: MEDLINE from 1966, EMBASE from 1980, CINAHL from 1982, PsycINFO from 1967, the Cochrane Central Register of Controlled Trials and PEDro.

Randomized controlled trials (RCTs) and Cluster RCTs that studied workers with work disability related to back pain were included .

Two review authors independently extracted data and assessed risk of bias.

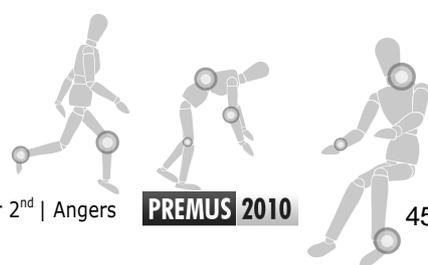
### Results:

Thirty-seven references, reporting on 23 RCTs (3676 workers) were included, 13 of which had a low risk of bias. Due to the small numbers of participants and heterogeneity of interventions only low to moderate quality evidence was found. In 14 studies, physical conditioning programs were compared to usual care. No effect on sickness absence was found for workers with acute back pain. Conflicting results were found for workers with subacute back pain. Sensitivity analysis showed a positive effect of workplace involvement with the interventions. Pooled results of five studies with workers with chronic back pain showed a small but no clinically worthwhile effect on sickness absence at the long term follow up (SMD: -0.18 (95% CI: -0.37 to 0.00)). In six studies physical conditioning programs were compared to exercise therapy and before two years follow up no or conflicting effects were found for workers with chronic back pain. In five studies no added value of cognitive behavioural therapy was found compared to physical conditioning programs or as an addition to such a program.

### Conclusion:

The effect of physical conditioning programs on sick leave remains uncertain for workers with back pain. These programs seem to have no effect on sick leave for workers with acute back pain but may have a positive effect for workers with sub acute or chronic back pain. Sensitivity analysis revealed a possible positive effect when programs involved the workplace. Before two years no clear difference in effect on sickness absence was found between physical conditioning programs and exercise therapy. More large high quality studies on physical conditioning programs are needed.

**Keywords:** Intervention methods, return to work, back, low back



## **DETERMINANTS FOR STAYING AT WORK IN PEOPLE WITH CHRONIC NONSPECIFIC MUSCULOSKELETAL PAIN: A SYSTEMATIC REVIEW.**

VRIES DE H.J.<sup>1,2</sup>, RENEMAN M.F.<sup>1,2</sup>, GROOTHOFF J.W.<sup>2,3</sup>, GEERTZEN J.H.B.<sup>1,2</sup>, BROUWER S.<sup>2,3</sup>

<sup>1</sup> Department of Rehabilitation Medicine, University Medical Center Groningen, University of Groningen, The Netherlands – <sup>2</sup> Graduate School for Medical Sciences, University Medical Center Groningen, University of Groningen, The Netherlands – <sup>3</sup> Department of Health Sciences, Section of Social Medicine, Work & Health, University Medical Center Groningen, University of Groningen, The Netherlands

### **Aims:**

Many people with chronic nonspecific musculoskeletal pain (CMP) report decreased levels in functioning, including functioning in work. Although many people with CMP have decreased workability, the majority appears to stay at work (SAW) despite CMP. It is currently unknown on which factors people who SAW differ from those who do not. The objective of this review was to identify determinants for SAW in people with CMP. The International Classification of Functioning, Disability and Health was used as a framework to classify the evidence.

### **Methods:**

An electronic search of bibliographic literature databases (Pubmed, Embase, PsychInfo, Cinahl and the Cochrane Library) from the dates that these databases begin up to October 2009, was performed. Two reviewers independently performed the screening of the abstracts and finally full text of the articles, to determine whether the article met the inclusion criteria. Included were articles reporting on working subjects between 20 and 60 years of age, with chronic nonspecific musculoskeletal pain. Subjects had to perform paid work and were not sick listed more than 5% because of CMP in the year prior to participation. During the selection phase, the reviewers were blinded for authors, affiliations, journal name and publication date. Two reviewers independently assessed the methodological quality of the included studies using standard criteria for assessing quality. Levels of evidence were rated.

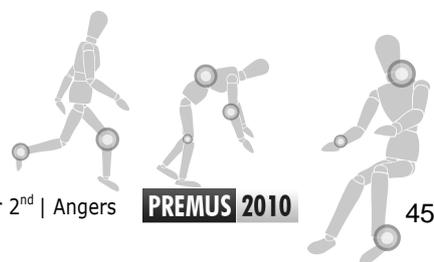
### **Results:**

The literature search resulted in 4828 potentially relevant articles. After screening on title and abstract, 4736 articles were excluded. Finally, 25 articles (6 qualitative and 19 quantitative articles) were included for full text assessment. Quality assessment and data-analysis are currently underway (January 2010). Results will be presented during PREMUS.

### **Conclusion:**

Discussion and conclusion will be presented during PREMUS.

**Keywords:** Psychosocial factors, Disability prevention, Pain, chronic pain



## FACTORS AT WORK ACTING AS BUFFERS AGAINST NECK/SHOULDER AND LOW BACK DISORDERS

LINDBERG P.<sup>1</sup>, LEIJON O.<sup>2</sup>, JOSEPHSON M.<sup>3</sup>

<sup>1</sup> University of Gävle, Gävle, Sweden - <sup>2</sup> Karolinska Institutet, Stockholm, Sweden - <sup>3</sup> Uppsala University, Uppsala, Sweden

### Aims:

The knowledge is limited about why some people with similar exposure are not affected by musculoskeletal disorders (MSDs) while others are. In an earlier study five factors, "content with number of working hours", "low demands", "role clarity", "performance appreciated by superior" and "no forward bent work posture", were identified to be uniquely promoting factors for excellent work ability, defined by the degree of sick leave(1). The aim of the present study was to test if these factors might act as buffers against developing neck/shoulder and low back disorders among employees with physically strenuous work.

### Methods:

From a Swedish cohort of public sector employees, that completed both a baseline and a 3-year follow-up questionnaire, two study groups were formed. Inclusion criteria: at baseline reporting having physically strenuous work and being free from either neck/shoulder disorders (n=335) or low back disorders (n=495) during the preceding year. The possible influence of the described promoting factors, working hours, demands, role clarity, performance appreciation and posture, was individually analysed by binary logistic regression analyses adjusted for age, sex and educational level. Those who still had no neck/shoulder or low back disorders at follow-up were compared with those who had developed such disorders.

### Results:

At follow-up the prevalence of neck/shoulder and low back disorders was the same in the two groups, 11%. Having moderate/low demands at work significantly increased the chance of not developing neck/shoulder disorders, OR 2.40 (95% CI 1.16-4.97). The chance of not developing low back disorders was significantly increased by having any of the three factors: getting one work performance appreciated by superior OR 1.85 (95% CI 1.02-3.32), having moderate/low demands, OR 2.65 (95% CI 1.47-4.80), or not having to work in a forward bent posture, OR 2.23 (95% CI 1.25-3.98). To be exposed to all three factors simultaneously increased the chance further, OR 3.44, 95% CI 1.51-7.82). The etiologic fraction for simultaneously having the three factors was 23%.

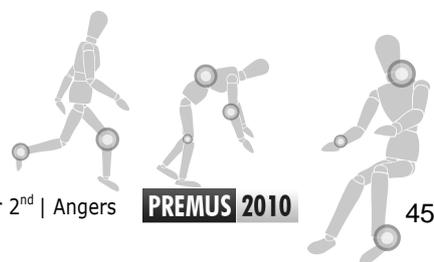
### Conclusion:

The results show that there seem to be factors at work acting as buffers against MSDs in the neck/shoulder and low back regions. Promoting these can be an additional tool for sustainable health at work.

**Keywords:** Epidemiology, Disability prevention, Prognosis of MSD

### References:

Lindberg P, Josephson M, Alfredsson L, Vingård E. Promoting excellent workability and preventing poor workability: the same determinants? Results from the Swedish HAKuL-study. *Occupational and Environmental Medicine*. 2006;63:113-120.



## REHABILITATION IS SELDOM PRESCRIBED AT THE INITIATION OF A NEW SICK-LEAVE PERIOD - A STUDY ON SICKNESS CERTIFICATES IN SWEDEN

NILSING E.<sup>1</sup>, SÖDERBERG E.<sup>2</sup>, ÖBERG B.<sup>1</sup>

<sup>1</sup> Department of Physiotherapy - <sup>2</sup> Department of Community Medicine. Division of Medical and Health Sciences, Linköping University, Sweden

### Aims:

To explore if patients were prescribed rehabilitation at the initiation of a new sick-leave period, and if this differed in relation to age, gender, diagnosis, description of functioning, and affiliation of certifying physician.

### Methods:

A longitudinal study using data from sickness certificates at baseline, i.e. the first certificate in a new sick-leave period, and from incoming certificates with prolongations of the current sick-leave spell. Rehabilitation was defined as a prescribed intervention comprising physiotherapy, counselling/therapy, occupational therapy, or a referral to a rehabilitation clinic. Rehabilitation prescribed in the first certificate, or within 28 days after the start of the sick-leave period, was defined as early rehabilitation, and late rehabilitation after 28 days.

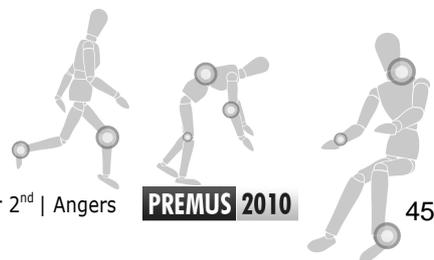
### Results:

In total, 1,312 certificates were issued to 475 patients. Each patient received in mean 2.8 certificates. Musculoskeletal diseases (MSD) were the largest diagnostic group, followed by mental disorders (MD). The majority of the certificates were issued for women. The mean number of days on sick leave was 94 (SD 139) with no differences between age intervals, gender, affiliation of certifying physician or diagnoses (ICD-10 codes). Rehabilitation was prescribed in the first certificate or within 28 days of sick leave (i.e. early rehabilitation) in about one fourth of the total certificates. Rehabilitation after 28 days of sick leave was rarely prescribed (8%). The logistic regression analysis showed that early rehabilitation was mainly prescribed for the youngest patients, MD or MSD, in certificates with a description of functioning according to the ICF components activity and participation, or certified from a primary or occupational healthcare physician. When controlling for all variables, the odds ratios remained highest for MSD and the youngest patients.

### Conclusion:

Rehabilitation is seldom prescribed early in the sick-leave period, according to information in sickness certificates. Even when the sick-leave period exceeds 28 days, prescription of rehabilitation is scarce. Whether early rehabilitation is prescribed, is determined by diagnosis and age of the patient.

**Keywords:** Health care workers, Return to work, Pain, Chronic pain



## THE IMPACT OF HEALTH SYSTEM COVERAGE AND BENEFIT DESIGN ON WORK INCENTIVES AND DISABILITY PREVENTION.

HIMMELSTEIN J.S., HENRY A.D., GETTENS J.W.

University of Massachusetts Medical School Center for Health Policy and Research, USA

### Aims:

This paper examines the impact of health care system design on work incentives and disability prevention using the current Massachusetts health care system as a case study.

### Methods:

Compared to the non-disabled, a higher percentage of U.S. working-age persons with disabilities rely on public health insurance coverage, 35.3 percent versus 6.7 percent. Also, compared to the non-disabled, the work participation of persons with disabilities is low, 39.1 percent versus 77.6 percent. One possible explanation for the low work participation is the work disincentive inherent in U.S. public health insurance programs. The disincentive is due to earnings limits and requirements that participants' work limitations preclude substantial earnings ability. Thus, persons may limit employment in order to obtain or maintain health insurance.

Unique to the U.S., Massachusetts enacted health care reform in 2007 to provide universal health insurance. The near universal coverage was achieved through a combination of an individual mandate, mandatory employer contributions, expansion of public insurance, and new subsidized and unsubsidized private insurance plans. Also unique, in 1987, Massachusetts expanded its means-tested public insurance program, Medicaid, to allow working persons with disabilities to 'buy-in', via premium payments, to Medicaid (CommonHealth Working) without earnings limits.

We analyze the work incentives of the Massachusetts health care system to understand the relationship between health insurance expansion and the employment of people with disabilities. We examine program rules, costs and service coverage. In addition we examine the change in employment status, health insurance status, health care access, and use before and after health care reform. Our data source is the Massachusetts Health Reform survey, a survey of approximately 3,000 adults conducted before and after health care reform.

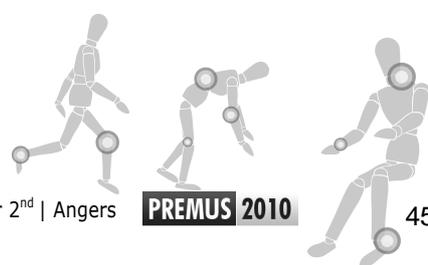
### Results:

The combination of the recent health care reform and the earlier CommonHealth Working expansion increased health insurance access for Massachusetts persons with disabilities. There are approximately 10.5 thousand CommonHealth Working participants and the current un-insurance rate among working-age adults with disabilities is only 4.8 percent. Nevertheless, the Massachusetts work participation rate among persons with disabilities (39.5 percent) is only marginally higher the national rate (39.1 percent).

### Conclusion:

Health care expansion has increased health insurance access and appears to be helpful in 'preventing' work disability for a sub-population of people with disabilities. However, the overall employment rate for persons with disabilities remains comparable to other states suggesting that health insurance is necessary but insufficient to substantially increase employment.

**Keywords:** Disability prevention, Return to work, Public policy



## IMPLEMENTING RETURN TO WORK INTERVENTIONS FOR WORKERS WITH LOW BACK PAIN: A CONCEPTUAL FRAME TO IDENTIFY BARRIERS AND FACILITATORS

FASSIER J.B., DURAND M.J., LOISEL P.

*Hospices Civils de Lyon & Université Lyon I, Lyon, France*

### Aims:

Workplace-based return-to-work (RTW) interventions for workers with subacute low back pain (LBP) are more effective than usual healthcare. Nevertheless, implementing such interventions usually faces many barriers within healthcare systems, workplaces and insurance systems [1]. The aims of this study were: 1) to build a conceptual frame to identify barriers and facilitators before implementing RTW interventions and 2) to validate empirically this conceptual frame.

### Methods:

A literature review was conducted to identify barriers and facilitators described in three domains: diffusion of innovations, implementation of healthcare programs and implementation of LBP clinical guidelines. A selection process was used to retain core dimensions identified. To validate this frame, a multiple case study with embedded levels of analysis was conducted in 2 regions of France [2]. Data were collected through semi structured interviews (22) and focus groups (7) with key-informants (63). Qualitative content analyses were performed with software Atlas.ti v5.2.

### Results:

A first frame was built from the literature, with 8 dimensions of the feasibility to be studied before implementation. This frame was eclectic as the dimensions had different theoretical backgrounds (psychology, sociology, etc.). After the phase of validation, some dimensions were modified resulting in a revised conceptual frame (figure) which was grounded theoretically and empirically.

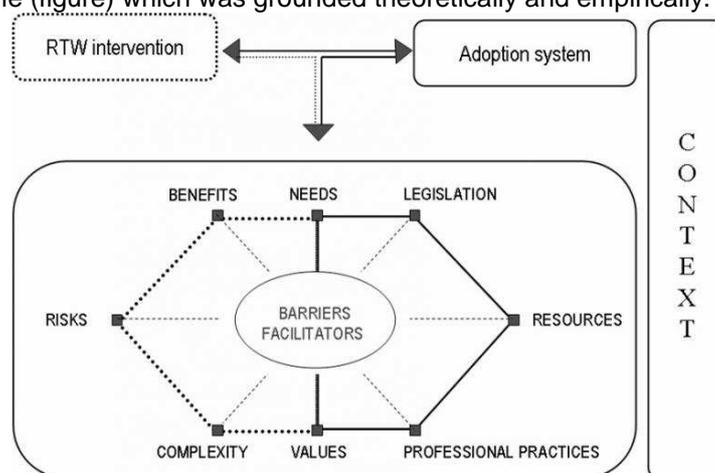


Figure: Conceptual frame to identify barriers and facilitators

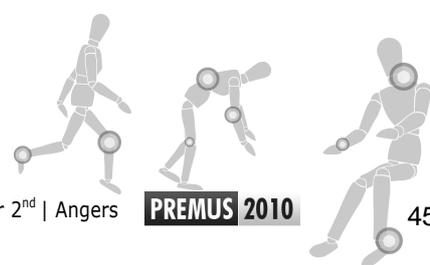
### Conclusion:

This conceptual frame is an important contribution in the field of implementation science. It can be used in various settings to identify barriers and facilitators prior to implementing RTW interventions. In line with recommendations in knowledge transfer, this identification will allow building evidence-based implementation strategies improving the uptake of the interventions and thus should facilitate work disability prevention among workers with LBP. This responds to a current priority in occupational and public health in many countries [3].

**Keywords:** Disability prevention, Return to work, Back, low back

### References:

- [1] Loisel P, Buchbinder R, Hazard R, Keller R, Scheel I, van Tulder M, et al. Prevention of work disability due to musculoskeletal disorders: the challenge of implementing evidence. *J Occup Rehabil.* 2005;15(4):507–524.
- [2] Yin, RK. Enhancing the quality of case studies in health services research. *Health Serv Res.* 1999; 34(5 Pt 2): 1209–1224.
- [3] European Agency for Safety and Health at Work. Work-related musculoskeletal disorders: Back to work report. Luxembourg: Office for Official Publications of the European Communities, 2007.



## EFFECTIVENESS OF A GLOBAL POSTURE REEDUCATION PROGRAM FOR PATIENTS WITH LOW BACK PAIN

BONETTI F., CURTI S., CURTI M., FERRARI C., PASANISI C., VIOLANTE F.S., MATTIOLI S., PILLASTRINI P.

*Section of Occupational Medicine, Department of Internal Medicine, Geriatrics and Nephrology, University of Bologna, Italy.*

### Aims:

Aim of this study was to evaluate the effectiveness of a Global Posture Reeducation (GPR) program in comparison to a physical therapy Standard Treatment (ST) in patients with low back pain (LBP) at short- and long-term follow-up (ie. 3 and 6 months).

### Methods:

The GPR is a physiotherapy approach which stretches the shortened antigravity muscles that are inside a different static muscles chain and actively involves the patient in postural and gestural changes.

A non-randomized clinical trial was conducted between March 2008 and September 2009. 100 consecutive patients with a primary complaint of LBP were included in the study: 50 entered the GPR group and 50 entered the ST group.

Primary outcome measures were Roland and Morris Disability Questionnaire (RMDQ) and Oswestry Disability Index (ODI). Secondary outcome measures were lumbar Visual Analogical Scale (VAS) and Fingertip-to-Floor test (FFT). Outcome measures were captured at baseline and at 3/6 months by a physical therapist blind to group allocation.

An intention to treat approach was used to analyze participants according to the group to which they were originally randomly assigned. The way of dealing with missing data was substitution with data of the 3rd-month follow-up (when available for the subject) and with the mean of the non-worsened subjects in ST group and of the non-improved subjects in RPG group.

### Results:

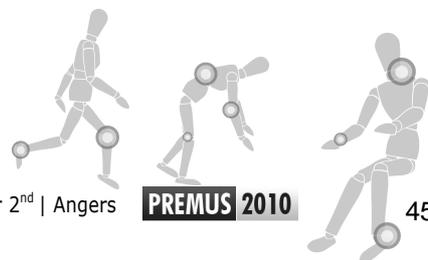
Of the 100 initial participants, 78 completed the study, 42 in GPR and 36 in ST group, respectively. At baseline, the two groups did not differ significantly with respect to gender, age, BMI and outcome measures. At the 6th-month follow-up, when examining differences from baseline, the RPG group revealed a significant reduction of all the outcome measures with respect to ST Group

The logistic regression model (adjusted for age, gender, BMI and white/blue-collar status) showed an increased likelihood of improvement at 6th-month follow-up (VAS reduction and at least 30% RMDQ reduction) for the RPG compared to the ST group (OR 2.75, 95% CI 1.18–6.43).

### Conclusion:

Our findings point to the relevance of a GPR intervention performed by a physical therapist in improving pain, disability and flexibility as opposed to a ST program, in patients with LBP. These results must be confirmed by further studies with higher methodological standards, including randomisation, large sample size, long-term follow-up and initial clinical assessment for subgrouping classification.

**Keywords:** Epidemiology, intervention studies, back, low back



## ROOMS FOR MANOEUVRE AND DIFFICULTIES MET BY FOREMEN AND THEIR ROLE FOR A SUSTAINABLE MSD PREVENTION

BUCHMANN W.<sup>1</sup>, ARCHAMBAULT C.<sup>2</sup>, VOLKOFF S.<sup>1</sup>

<sup>1</sup> CREAPT, Noisy Le Grand, France – <sup>2</sup> Eurocopter, La Courneuve, France

### Aims:

During their investigations, Caroly and coll. (2008) noticed the difficulties met by foremen when they intend to take care of questions of health at work, while their role on this subject is essential.

In a 700 employees plant of a big company in the aircraft manufacturing sector, the purpose of our study was to identify indicators, rooms for manoeuvre, and the difficulties met by team leaders and foremen, to keep at work the operators whose musculoskeletal disorders do not allow them to cope with the workstation any more.

### Methods:

To identify the operators having changed of workstation for medical reason, we used the 2006-2008 exploitations of a longitudinal observatory called EVREST (Work-Health Relationship Assessment Over Time) created and used in the company since 2000.

Further to the results supplied by analysing these data, semi-directed individual interviews are at present led by a binomial composed by an occupational doctor and an ergonomist. The foremen responsible of operators who changed workstation are interviewed twice. The purpose of these interviews is to reconstitute the story of the transfer.

The answers supplied by foremen will allow to identify the temporal course of the transfer, their representations of health and work of the operator, the brakes they encounter and the control levers of action which they may use in order to solve the problem, propose and estimate the possible solutions in short, medium, long terms.

### Results:

The study being in progress, the results are only very partial so far; complementary results will be supplied in the final document. However, the data analysis of the EVREST observatory highlights that among a population of 450 operators and technicians, during a period between 2006 and 2008 included, 59 had experienced a limitation or a temporary or definitive inaptitude in their workstation, among which 50 because of musculoskeletal disorders.

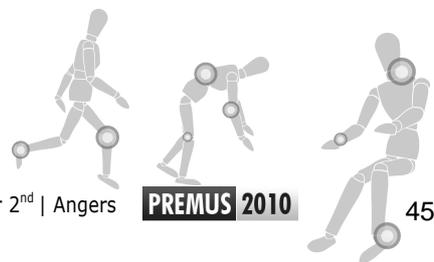
### Conclusion:

In order to manage (even to anticipate) the gap between the physical and psychical resources of a worker, and the requirements of the activity which he realizes, certain regulations (like organizational or technical, individual or collective regulations) must be undertaken (Haïlé-Fida, 2005). This research puts forward this activity of regulation realized by foremen so as to facilitate its expression, for a sustainable MSD prevention.

**Keywords:** Work organization, Disability prevention, Return to work.

### References:

- Caroly, S., Coutarel, F., Escriva, E., Roquelaure, Y., & Schweitzer, J.M. (2008). La prévention durable des TMS. Quels freins? Quels leviers d'action? Sous la direction de François Daniellou. Rapport final Direction Générale du Travail.
- Haïlé-Fida, S. (2005). Quelle place pour la maîtrise de proximité dans la détection et la prise en charge de l'usure professionnelle? Le cas d'une société de transports urbains de voyageurs de la région Rhône-Alpes. Revue de l'IRES, n°4



## EVALUATION OF A PHYSIOTHERAPY CARE WITH A MULTIDISCIPLINARY INTERVENTION INCLUDING MEDICAL AND ERGONOMIC APPROACH

DEVARENNE V., TARIN C., PRECHAC A., WINCKEL M.

GENERAL ELECTRIC HEALTHCARE, Buc, France

### Aims:

We aimed to evaluate a complementary approach based on workstation ergonomic risk exposure associated with a structure to provide physiotherapy in order to decrease consequences of musculoskeletal disorders (MSD).

### Methods:

Each patient with MSD is reviewed by means of a multidisciplinary approach including the occupational physician and nurses, the physiotherapist, and the ergonomist. The intervention included interviews and ergonomic assessment of the workstation. The physiotherapy treatment was based on the MSD, taking into account that sessions are participative: employees need to take action on the job and at home to prevent any risk of relapse. A qualitative evaluation was performed with a perception survey launched 6 months after the beginning of the initiative; evaluation of the complete care (ergonomic improvements and physiotherapy) with a focus on worker satisfaction, potential days off work, and daily work life improvements. A quantitative evaluation was performed through "before and after" exercises and interviews to evaluate mobility of movements and pain reduction (numeric pain scale from 1 to 8).

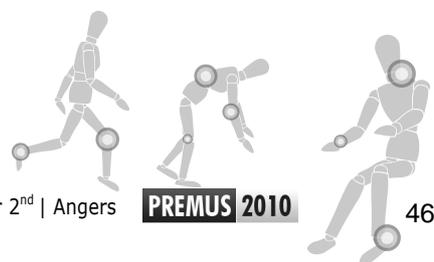
### Results:

Between February 2009 and August 2009, 32 patients have been included aged from 26 to 60 years, mostly men (n= 62% of the patient). Most workers are satisfied (95% n= 30) with the therapy sessions and recommend them to their colleagues; 95% have experienced an improvement in their work day life and 38% would take sick leave if they did not receive this therapy. Mean pain level was reduced by 71% (from 7 to 2). Workers declared they had "more energy, felt more comfortable and had better concentration in their work day life". Exercises, performed on people who had limited mobility, showed +30% improvement of motion.

### Conclusion:

Our results seemed to highlight a complementary approach to the traditional ergonomic assessment and interventions. In particular, it seemed to increase the benefit of biomechanical exposure reduction and to reinforce the close association between individual health and ergonomic culture.

**Keywords:** Health care workers, Early prevention, Return to work.



## THE BENEFITS OF PHYSICAL THERAPY TRAINING FOR LOW BACK PAIN AT WORK.

DELORE-MILLES E.<sup>1</sup>, BROSSET N.<sup>1</sup>, BUCHHOLZ F.<sup>1</sup>, TOUSSAINT J.F.<sup>2</sup>, HASSIF H.<sup>2</sup>, ANDLAUER C.<sup>1</sup>, BRIQUET-WAGNER A.<sup>1</sup>, SCHOHN M.<sup>2</sup>

<sup>1</sup> PSA Peugeot Citroën, Mulhouse, France - <sup>2</sup> IRMES, Paris, France.

### Aims:

Our hypothesis was that physical therapy at work could bridge the gap between staying at home and returning at work. Low back pain weans people away from physical effort, at work and in their private life. To avoid any risk of pain chronicity, we assumed that in addition to prevention, offering pro-active rehabilitation at work drives better on life's quality, minimize kinesiphobia and, absenteeism and finally enhance post back pain recovery.

### Methods:

To challenge our hypothesis, we used two groups : first one undergoing 24 physiotherapy sessions within 2 months, and second one (test group), without physiotherapy; initially the two groups were homogeneous.

Assessments were realized at three time points: before treatment, at the end of the treatment and three months after the completeness of the treatment. 21 measures were recorded: pain (EVA, McGill), physical capacity (strength, mobility, and flexibility), and life's quality, frequency of medical survey, physical activity, weight, and absenteeism.

Physiotherapy session included stretching, strength training, flexibility, balance, proprioception, breathing and working body schema.

### Results:

The initial assessment indicated an overall low level of fitness in the two groups. Low back pain persons were no enduring and could not perform some of the tests because of injury fear and/or of inability fear.

Two months after enrolment in the study/program, we could observe a real decrease on kinesiphobia, improvement of extensibility, quality of life, lowering of pain (data statistically significant).

### Conclusion:

Staying at home increases disability and, consequently, lowers chances to return to work where good fitness is required. Low initial physical condition was observed among people being at work and suffering of lumbar pain. Our observation indicates that a portion of the population at work is at risk and injury is likely to occur.

The decrease in kinesiphobia enhanced the workers' ability to learn and adopt new movements. This enabled them to stay at their workplaces and improve their capability of adaptation to the changes (new duties, new work cadence...) at work.

The "lumbar program" coached the manual workers and helped them to be in better health and return at work earlier. Physiotherapy contributes to increase physical capacity and decrease kinesiphobia (factor of vocational rehabilitation). For these reasons the PSA company is planning to hire physical therapists for each plant.

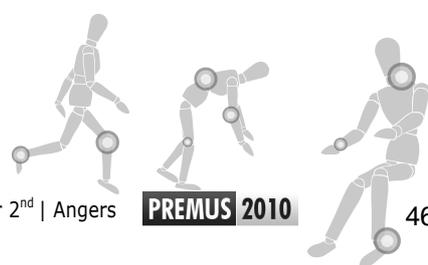
**Keywords:** Intervention studies, Return to work, Back, low back.

### References:

Bontoux L, Dubus V, Roquelaure Y, Colin D, Brami L, Roche G, and coll. Return to work of 87 severely impaired low back pain patients two years after a program of intensive functional restoration. *Ann Phys Rehabil Med.* 2009 Feb; vol 52-issue 1 : p17-29.

Code du travail. Art L323-17, ord n°2007-329, (March 12, 2007).

ANAES. Diagnostic, prise en charge et suivi des malades atteints de lombalgie chronique. Dec 2000.



## THE MANAGEMENT OF SICKNESS ABSENCE IN THE TRANSPORT INDUSTRY - A 10 YEAR EXPERIENCE

FARRAND D.J.E.

*Heimdall Occupational Health*

### **Aims:**

In spite of many modifications to driver seating, vehicle ergonomics and shift routines, sickness absence in the industry failed to show any significant improvement. By intensive management of musculo-skeletal injuries and application of practical ergonomic principles and manager education, a sustained improvement of 50% or more reduction in driver absence was obtained

### **Methods:**

Forensic audit of the evidence provided by the company in respect of all work-related occupational musculo-skeletal injuries. Intensive assessment of patient history. Thorough musculo-skeletal examination. Ergonomic advice to company managers, where appropriate. Management action to counsel affected individuals

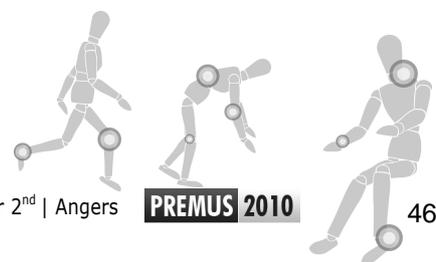
### **Results:**

With each national company assisted, an over 50% reduction in annual sickness absence was achieved, reducing this statistic from 10 to 11% to 5% or less

### **Conclusion:**

Efficient management of work-related musculo-skeletal injury can benefit both the employee and the employer and this improvement can be maintained in the long-term by education of the individual and management.

**Keywords:** Vibrations, driving, Disability prevention, Return to work



## DISPUTED CHRONIC NEUROGENIC THORACIC OUTLET SYNDROMES: RESULTS OF A MULTIDISCIPLINARY APPROACH OF THE RETURN TO WORK

FOUQUET B., BORIE-MALAVIEILLE M.J., BADAOUI S., METIVIER J.C., PELLIEUX S., LAULAN J.

University of Tours - Physical Medicine and Rehabilitation Center and Orthopaedic Surgery Department, Hôpital Trousseau- CHU, 37044 Tours, France

### Aims:

Despite early interventions by occupational physicians, upper limb complaints may persist and become chronic. Such patients must be assessed and treated by a multidisciplinary team. The purpose of this study was to evaluate the functional and return to work results of a multidisciplinary treatment of patients suffering from chronic disputed neurogenic thoracic outlet syndrome (DnTOS)

### Methods:

338 patients suffering from chronic DnTOS (positive Roos's test and Morley's test) have been included in this study from June 2004 to June 2009. The population consisted of 239 women and 99 men (mean age 42.8 years; S.D. 9.1). The mean duration of the work disability was 10.4 months. All patients have been assessed before treatment for physical, psycho-affective and social factors. The program consisted of treatment of nerve sensitization with clomipramine associated with physical exercises, aerobic training and stretching during 6.30 hours per day, 5 days per week during 4 consecutive weeks. All patients have been assessed again after 6 months. 23 patients (6.8%) have been excluded during the protocol.

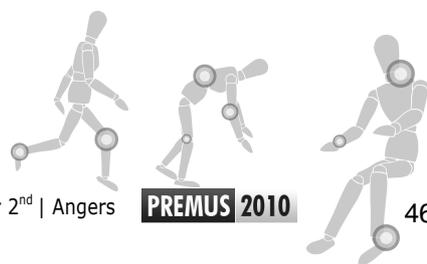
### Results:

A total of 228 out 338 patients (67.4%) were satisfied and improved by the program, while 87/338 (25.9%) were not satisfied and had no improvement. The prognostic factors, at baseline, were the mean score of work disability ( $p < 0.004$ ) and FABQ "work" ( $p < 0.01$ ), the occurrence of comorbidities ( $p < 0.01$ ) and the job satisfaction ( $p < 0.009$ ). 212 (62.7%) patients were able to return to the same job without adaptation. 101 (29.9%) had to change of job and 22 (6.5%) returned to a modified job in the same company. Only 3 patients were proposed for a definitive disability. The efficient return to work was associated with the following prognostic factors assessed at baseline: the DASH score ( $p < 0.0002$ ), mean age ( $p < 0.0001$ ), mean duration of sick leave ( $p < 0.0001$ ), FABQ scores of "work" ( $p < 0.0001$ ) and "physical activity" ( $p < 0.009$ ) and mean pain intensity ( $p < 0.002$ ).

### Conclusion:

Our results are in agreement with others open studies on multidisciplinary approach of musculoskeletal disorders of the upper limbs and low back. The two main prognostic factors are the duration of work disability and the FABQ "work". So, the modalities of return to work for patients with a long work disability had to be resolved before the multidisciplinary approach.

**Keywords:** Return to work, Upper limb, Pain, chronic pain.



## THE FEAR AVOIDANCE MODEL RELATION SHIPS WITH THE READINESS FOR RETURN TO WORK SCALE IN DIFFERENT MUSCULOSKELETAL DISORDERS

FOUQUET B., BADAoui S., BORIE-MALAVIEILLE M.J., METIVIER J.C., PELLIEUX S.

University of Tours - Physical Medicine and Rehabilitation Center, Hôpital Trousseau- CHU, 37044 Tours, France

### Aims:

The fear-avoidance model of pain is considered as the best model of chronic stages of pain [1]. Few studies have been conducted in patients suffering from chronic non specific neurogenic pain of the upper limbs (CULP). The purpose of this study was to evaluate the relationships of the fear avoidance model with various musculoskeletal disorders and its correlations with the French version of the Readiness for Return-to Work (RRTW) scale [2].

### Methods:

328 patients (205 women and 123 men; mean age 43.9 years; S.D. 9.6 years) suffering from chronic low back pain (134 patients) (CLBP) and from CULP (194 patients) have been included in this study. Their neuropathic score (DN4 score) was comprised between 1 /10 and - 4/10). All patients were assessed using self-administered questionnaires gathering information on catastrophism, FABQ, intensity of pain, DASH (for the CULP) and the French version of the Rolland and Morris scale (EIFEL) for the CLBP, and a French version of the RRTW scale. Physical tests included endurance test for the upper limbs in CULP and Sorensen's and P.I.L.E. tests for CLBP.

### Results:

Multivariate analyses fund differences between the two groups of patients. The fear avoidance model fitted well with pain, disability scores and catastrophism. Physical tests were significantly correlated with pain intensity and disability scores only in the CULP group. Regarding the RRTW scale, the highest coefficients of correlation were observed between the FABQ "work" scale and the "uncertain maintenance", the "proactive maintenance" and the "contemplation" dimensions ( $p < 0.0001$ ). FABQ "work" scores were significantly correlated with the duration of work disability. The scores of "prepared for action (self-assessment)" were significantly correlated with the scores of "uncertain maintenance" ( $r = 0.49$ ) and "proactive maintenance" ( $r = 0.50$ ) in both groups.

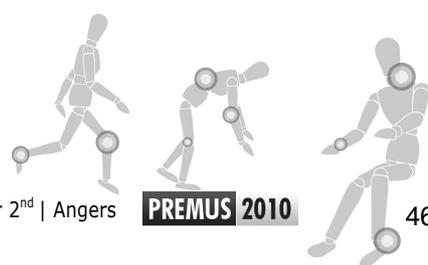
### Conclusion:

Our study confirms that the fear-avoidance model may explain the mediation from the disability to fear avoidance via the catastrophism. Unfortunately, the disuse syndrome (diminished performances) was not associated with the increase of the FABQ scores or with the duration of the sick leave, but with the disability scores and this was observed only in the CULP patients. The correlation between the FAQB "work" and the "contemplation" dimension of the RRTW scale suggests ambiguous and passive attitude for the return to work.

**Keywords:** Psychosocial factors, Return to work, Pain, chronic pain.

### References:

- Leeuv m, Goosens MEJB, Linton SJ, Crombez G, Boersma K, Vlaeyen JWS, The fear-avoidance model of musculoskeletal pain : current state of scientific evidence J Behavior Med 2007;30(1):77-94  
Franche RL, Corbière M, Lee H, Brueslin FC, Hepburn CG The Readiness for Return-to-Work (RRTW) Scale :development and validation of a self report staging scale in lost-time claimants with musculoskeletal disorders J Occup Rehabil 2007;17:450-472



## BACK TO WORK AFTER DORSAL MUSCULOSQUELETAL DISORDERS: THE ROLE OF THE COMPANY

KERN F., GONIK V., DANUSER B.

*IST, Institute for Work and Health, Rue du Bugnon 21, 1025 Lausanne, Switzerland*

### Aims:

Going back to work after a longterm absence for dorsal Musculoskeletal Disorder (MSD) depends on various factors such as working conditions, state of health or workplace adaptation. A Swiss National research project is currently investigating the rehabilitation process.

The aim of this paper is to investigate the role of the swiss company in this going back to work process.

### Methods:

The return to work process of 17 subjects who followed a rehabilitation program were qualitatively analysed and 5 typologies were identified

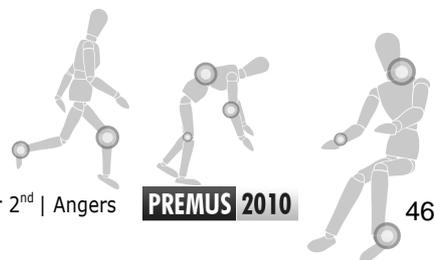
### Results:

- rapid and persistent return to work with ergonomic adaptations
- rapid but non persistent return to work with no ergonomic adaptation
- slow and persistent return to work with ergonomic adaptation
- no return to work with no ergonomic adaptation
- change of work

### Conclusion:

A relevant support from the companies via ergonomic adaptations at the workplace appeared to be decisive for a successful return to work.

**Keywords:** Intervention studies, Return to work



## DIFFICULTIES AND OBSTACLES IN THE RETURN TO WORK OF WORKERS AFFECTED BY OCCUPATIONAL DISEASES ATTENDED TO IN A REFERENCE CENTER FOR THE WORKER'S HEALTH IN SAO PAULO – BRAZIL

LANCMAN S., DALDON M.T.B., SANTOS M.C., TOLDRÁ R.C.

*Department of Physical Therapy, Communication Science & Disorders, Occupational Therapy of the Faculty of Medicine, University of São Paulo, Brazil*

### Aims:

To know the subjective and objective embarrassments experienced by workers in their return to work and the coping strategies used. To develop studies that subsidize public policies which integrate prevention, healthcare, rehabilitation and return to work.

### Methods:

A qualitative and empirical study, based on reflections derived from group sessions and data from medical records of workers treated at a Reference Center for the Worker's Health—CRST. The CRSTs are part of the Unified Health System(SUS) and perform interventions in companies, Interdisciplinary sessions and return to work programs.

The group was composed of workers with a long period of work leave and permanence at CRSTs, passage through various forms of clinical care and poor treatment results. The groups were designed to create space for reflection, allowing the exchange of experiences and the reappropriation of the limiting factors for the rehabilitation, and ways of overcoming them.

### Results:

Six of the ten participants were men (ages 35 to 55), with low educational level and unqualified professional training.

They exerted mostly activities with intense physical strain and repetitive movements, presented neuromuscular-skeletal disorders, pain, movement and muscle strength alterations and mental impairments.

After failed attempts to return to work, the participants remained unemployed or on leave. Among the complicating aspects of the return to work are the long period of work leave (about 46 months), of treatment (about 50 months) and the delay in starting professional rehabilitation (about 30 months). The work conditions and organization, and the bureaucratic procedures in Social Security proved to be an additional factor of hardship.

The participants had received various types of treatment and despite acknowledging improvements in symptoms, maintained the same complaints and incapacity to do previously performed work.

### Conclusion:

The results demonstrate the disarticulation of the health, education, employment and social security systems, and the last's noncompliance with its duties (it doesn't rehabilitate nor provides return to work), exposing the workers to embarrassment and feelings of distrust.

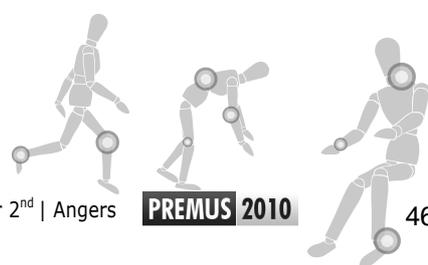
It was concluded that the losses were many and that the physical aspects interfered with the mental and vice versa. This, combined with low education and training, hindered the return to work and engagement in new activities.

The exclusion from work caused strong psychological impact, constituting a blow to their sense of identity and leading to the disruption of social networks, life projects and careers. Prolonged exposure to these conditions hindered the return to work.

**Keywords:** Psychosocial factors, intervention studies, return to work

### References:

BRASIL.(2008) Anuário Estatístico da Previdência Social – 2007 divulgado em 02/10/2008. From [http://www1.previdencia.gov.br/aeps2007/16\\_01\\_03\\_01.asp](http://www1.previdencia.gov.br/aeps2007/16_01_03_01.asp)., OMS. ORGANIZAÇÃO MUNDIAL DA SAÚDE: Classificação Internacional de Funcionalidade, Incapacidade e Saúde [Centro Colaborador da Organização Mundial da Saúde para a Família de Classificações Internacionais. São Paulo: Editora da Universidade de São Paulo – EDUSP; (2003), 328p., GRAVINA, M.E.R.; NOGUEIRA, D. P. ROCHA, L. E. Reabilitação profissional em um banco; facilitadores e dificultadores no retorno ao trabalho. Rev. Ter. Ocup. Univ. São Paulo.2003: 14:19-26



## CONTRIBUTIONS OF GROUP PHYSICAL THERAPY SESSIONS TO THE RETURN TO WORK OF PATIENTS WITH WORK RELATED MUSCULOSKELETAL DISORDERS (WRMD)

LANCMAN S., MENDES L.F.

*Physical Therapy Program of the Methodist University of São Paulo, São Bernardo do Campo, Brazil -Department of, Communication Science & Disorders, Occupational Therapy of the Faculty of Medicine, University of São Paulo, Brazil*

### Aims:

This is a clinical study comparing two types of treatment: individual and group kinesiotherapeutic intervention. Both interventions included discussions on the nature of the disease, its impact on people's personal and professional lives and ways of coping and living with pain. The objective was to evaluate the benefits of combining kinesiotherapy with group dynamics that focused on a more integral approach to the health-disease process and the recovery and rehabilitation process of WRMD patients regarding both functionality and return to work.

### Methods:

24 patients diagnosed with WRMD were divided randomly into two types of intervention (individual and group). The kinesiotherapy protocol was the same in both and lasted for 10 sessions. After the exercises, selected issues were addressed, such as; causes of becoming ill, limitations imposed by the clinical conditions, alternatives for performing activities of daily life, the difficulties of pain treatment, the illness' impact on family and professional life, and the active participation of patients in their treatment and return to work. In order to standardize the two interventions we created a strategy to enable the reflection process. In the individual sessions small stories containing the same themes proposed in the group sessions were read, and the participants encouraged to comment on them. The interventions were analyzed through semi-structured interviews to qualitatively assess their impact on the clinical condition and the post-treatment quality of life.

### Results:

The analysis of the interviews revealed a perception of improvement of symptoms in all patients. The interventions had different effects on improving the functionality and the discourse used by the patients. Some individual participants continued to present difficulties in executing activities, while among the participants in group intervention there was a greater perception of functional improvement. In both interventions there was no identifiable increase in the return to work, but there was an increase in the desire and the motion towards it. The presence or recollection of pain and the fear of reliving the situations that caused the illnesses were limiting factors.

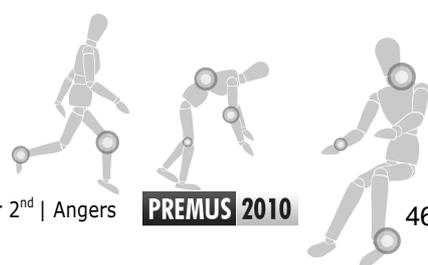
### Conclusion:

It is necessary to know the subjective aspects and the individuals' perception of their own recovery and rehabilitation process to better evaluate the treatment's efficacy. The possibility of reflection created in both interventions allowed for a more integral view of the illness, recovery and rehabilitation process, especially among those who participated in the group, but this was not enough to guarantee a return to work.

**Keywords:** Intervention methods, return to work, social aspects of MSD

### References:

- BRASIL. Ministério da Saúde. Doenças Relacionadas ao Trabalho: Manual de Procedimentos para os Serviços de Saúde. Brasília, 2001.,  
KONIJNENBERG, H. S.; WILDE, N. S.; GERRITSEN, A. A. M.; VAN TULDER, M. W.; DE VET, H. C. W. Conservative Treatment for Repetitive Strain Injury. *Scandinavian Journal Work Environ Health*.v. 27, n. 5, p. 299-310,2001,  
MARINHO, P. E. M. Refletindo sobre a expressividade da dor e a relação terapeuta-paciente.*Fisioterapia em Movimento*, v.18, n. 2, p. 73-79, 2005.



## VALIDATION OF THE 11-ITEM ORGANIZATIONAL POLICIES & PRACTICES SCALE (OPPS) FOR INJURED WORKERS RECOVERING FROM WORK-RELATED UPPER-LIMB DISORDERS

TANG K., AMICK B.C., MACDERMID J., BEATON D.E.

St. Michael's Hospital, Toronto, Canada; Institute for Work & Health, Toronto, ON, Canada; McMaster University, Hamilton, ON, Canada.

### Aims:

Supportive organizational practices toward workplace safety and disability management are believed to promote injury prevention and better work disability outcomes for injured workers (IWs) (1). However, validation of instruments aimed at quantifying this construct has not been widely demonstrated to-date. Our objective is to evaluate the psychometric properties and factor structure of the Organizational Policies & Practices scale (OPPs) (2) for IWs.

### Methods:

Consenting IWs (n=614) attending a WSIB Shoulder & Elbow Specialty clinic (3) in Ontario, Canada, were invited to complete the OPPs upon initial clinic visit. The full OPPs is scored by taking the mean of all 11 items (5 response options, 1-5, 5=most supportive workplace policies/environment), or by a subscale structure proposed by the scale developers (4 factors: people-oriented culture, safety climate, disability management, ergonomic practice). Score distributions (normality, floor/ceiling effects) were examined at the scale, subscale-, and item-levels using descriptive statistics. Internal consistency (Cronbach's alpha, item-total correlations) and construct validity (Spearman r, t-tests between known-groups) were also assessed. Both confirmatory (CFA) and exploratory factor analyses (EFA) were conducted to verify the factor structure of the measure.

### Results:

A OPPs mean of 2.9 (SD=0.8) was revealed in our study sample. No floor or ceiling effects in score distributions were evident at the scale or subscale levels. Item mean ranged from 2.1 to 3.2, and acceptable item-total correlations ( $r=0.5-0.7$ ) were observed. OPPs scores demonstrated the expected level of correlation with moderately-related constructs, including perceived supervisor support ( $r=0.55$ ) and perceived job satisfaction ( $r=0.48$ ). In addition, scale scores were able to discriminate between IWs who were offered work-accommodations and those who were not (mean=3.0 vs. 2.6,  $t=5.76$ ,  $p<.0001$ ), as well as IWs who were contacted by workplace shortly after onset of injury versus those who were not (mean=3.1 vs. 2.5,  $t=7.40$ ,  $p<.0001$ ). Results from both CFA (RMSEA=0.097, TLI=0.91, NFI=0.93, CFI=0.94) and EFA (promax rotation) offered converging support for the proposed 4-factor organization, however, scoring by subscales was associated with lower alphas (range=0.78-0.88) compared to scoring of the OPPs as a full 11-item measure (alpha=0.89).

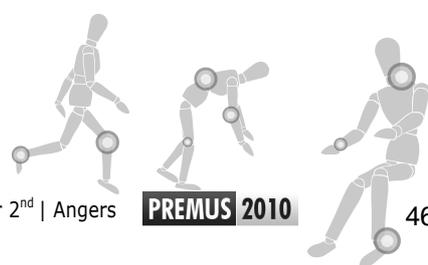
### Conclusion:

Evidence for the reliability, validity, and factor structure for the OPPs for use in IWs with upper-limb disorders is demonstrated. From a psychometric perspective, current results suggest that the application of the OPPs as an 11-item measure, rather than as subscales, is most appropriate.

**Keywords:** Work organization, epidemiology, disability prevention

### References:

- (1) Habeck RV, Leahy MJ, Hunt HA, Chan F, Welch EM. Employer factors related to workers' compensation and disability management. *Rehab Couns Bull.* 1991;34:210-236.,
- (2) Amick III BC, Habeck RV, Hunt A, Fossel AH, Chapin A, Keller RB, Katz JN. Measuring the impact of organizational behaviors on work disability prevention and management. *J Occ Rehabil.* 2000;11:21-38.,
- (3) Workplace Safety Insurance Board (WSIB) of Ontario. Shoulder and Elbow Program. Information available from (accessed October 2009):<http://www.wsib.on.ca/wsib/wsibsite.nsf/Public/HealthSpecialtyShoulderElbow>



**MUSCULOSKELETAL DISORDERS AT A POPULATION LEVEL****HEALTH BELIEFS AND HEALTH WORRIES: PREDICTORS OF CARE-SEEKING WITH BACK PAIN OR ANY MUSCULOSKELETAL PAIN IN A COHORT OF THE GENERAL WORKING POPULATION**

JENSEN J.C., HAAHR J.P., ANDERSEN J.H.

*Department of Occupational Medicine, Danish Ramazzini Centre, Regional Hospital Herning, Denmark.***Aims:**

It is unclear why some patients with musculoskeletal pain consult their General Practitioner (GP), while others with the same pain do not. This study intends to examine the association between indices of health worries and health beliefs and care-seeking with back pain (BP) or any musculoskeletal pain (MP).

**Methods:**

8,517 men and women, between the ages 17 and 65 years, listed with eight General Practitioners (GPs) were addressed by a baseline questionnaire with a response rate on 60%, of whom 4,325 (85%) were employed. In accordance with the Danish version of ICPC, all diagnoses were registered by the GP for the next eighteen months. Patients given a diagnosis of any musculoskeletal pain were recruited for the study. Health worries and beliefs were measured by the Whiteley Index and the Fear Avoidance Belief Questionnaire. Associations between baseline risk factors and 1) BP, and 2) MP were assessed by logistic regression with adjustment for age, gender, general health and mental health. Findings are expressed in Odds Ratios (ORs) with 95% confidence intervals. (CIs)

**Results:**

Within 18 months from baseline, 509 (12%) became cases with BP and 1.329 (31%) with MP. High fear-avoidance and many health worries were associated with care-seeking, indicating an exposure – response relationship, and this association remained after adjusting for general health and mental health (table 1). Women had a slightly elevated risk on 20-30% compared to men.

Table 1.

**Factors predicting care-seeking with back pain or any musculoskeletal pain.**

Variable	n	Odds Ratio*, back pain (95 % CI)		Odds Ratio*, any musculosk. pain (95 % CI)	
		crude	adjusted <sup>1)</sup>	crude	adjusted <sup>1)</sup>
<b>Sex</b>					
Male	1.939	1.0	1.0	1.0	1.0
Female	2.386	1.33 (1.10 - 1.61)	1.31 (1.07 - 1.61)	1.17 (1.03 - 1.33)	1.18 (1.02 - 1.35)
<b>Agegroup (years):</b>					
17 - 29	625	1.0	1.0	1.0	1.0
30- 39	837	1.43 (1.00 - 2.04)	1.32 (0.91 - 1.90)	1.20 (0.95 - 1.53)	1.12 (0.87 - 1.44)
40 -49	1.245	1.68 (1.21 - 2.34)	1.50 (1.06 - 2.11)	1.70 (1.36 - 2.11)	1.53 (1.21 - 1.93)
50 - 59	1.296	1.63 (1.18 - 2.26)	1.42 (1.01 - 2.02)	1.70 (1.63 - 2.10)	1.56 (1.23 - 1.97)
60 +	322	1.09 (0.69 - 1.75)	1.05 (0.63 - 1.74)	1.49 (1.10 - 2.01)	1.44 (1.04 - 1.98)
<b>Fear-Avoidance:</b>					
low	949	1.0	1.0	1.0	1.0
Moderate	1.846	1.33 (1.02 - 1.73)	1.22 (0.93 - 1.61)	1.26 (1.06 - 1.50)	1.22 (1.01 - 1.46)
High	1.392	1.67 (1.27 - 2.18)	1.42 (1.06 - 1.89)	1.34 (1.12 - 1.61)	1.26 (1.04 - 1.53)
<b>Health Worries:</b>					
Low	1.618	1.0	1.0	1.0	1.0
Moderate	1.286	1.41 (1.10 - 1.82)	1.25 (0.96 - 1.62)	1.22 (1.04 - 1.44)	1.09 (0.93 - 1.30)
High	1.275	2.28 (1.81 - 2.88)	1.79 (1.36 - 2.34)	1.60 (1.37 - 1.88)	1.25 (1.04 - 1.51)

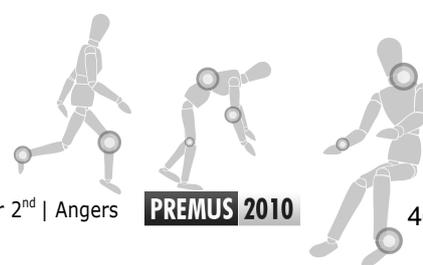
\* Odds Ratios with 95 % confidence intervals obtained by logistic regression.

1) Adjusted for sex, agegroup, general health, mental health, fear-avoidance and health worries.

**Conclusion:**

This study reveals that indices of health beliefs and worries are predictors of becoming a case with either back pain and/or other musculoskeletal pain. Effects probably go beyond health status at baseline, and support the notion that health beliefs and worries could be important targets for stay at work/return to work activities.

**Keywords:** Personal risk factors for MSD, Back, low back, Pain, chronic pain



## INCIDENCE OF SHOULDER LESION DIAGNOSES IN SOUTHERN SWEDEN – DATA FROM A POPULATION-BASED HEALTH CARE REGISTER

TEKAVEC E.<sup>1</sup>, JÖUD A.<sup>2</sup>, RITTNER R.<sup>1</sup>, MIKOCZY Z.<sup>1</sup>, NORDANDER C.<sup>1</sup>, PETTERSSON I.F.<sup>2</sup>, ENGLUND M.<sup>2</sup>

<sup>1</sup> Occupational and Environmental Medicine, University Hospital, Lund, Sweden – <sup>2</sup> Musculoskeletal Sciences, Department of Orthopedics, Clinical Sciences Lund, Lund University, Lund, Sweden.

### Aims:

Skåne, Sweden's southernmost county, has 1.2 million inhabitants. Inpatient and outpatient clinic visits to a physician in the county are registered in the Skåne Health Care Register. For visits to a public health care provider, data on diagnosis (ICD-10) and a personal identifier are transferred to a central database. Shoulder lesions are often caused by inadequate occupational conditions, why these diagnoses are of particular interest. Our objective was to estimate the annual incidence of shoulder lesion diagnoses.

### Methods:

An incident case was defined as a subject seeking care and receiving a shoulder lesion diagnosis (ICD-10 M75.0-M75.9) during 2008, but not during the preceding 5 calendar years period. We used the total population in Skåne by 31 December 2007, compensated for loss of patients only seen by private practitioners (estimated to 20%), as the denominator to obtain incidence estimates. Data was stratified by age and gender.

### Results:

During 2008, 4584 incident cases were registered (52% females), yielding an annual incidence of 49 per 10 000 for females, and 47 per 10 000 males. For adults (aged 20 years or older) the annual incidence was 62 per 10 000. Most common diagnoses were rotator cuff and impingement syndromes, which together represented 56% of cases for females, and 63% for males. The incidence increased from entrance in working life (age ~20) and decreased after retirement (age 65) (Figure).

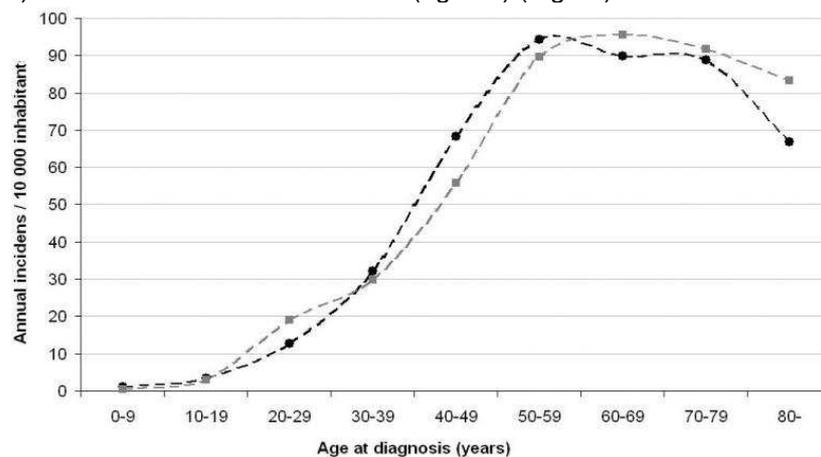


Figure. Incidence per 10-year age intervals. Females black, round symbols, males grey squares.

### Conclusion:

The annual incidence peaked at retirement age, and shoulder diagnoses with a possible relationship to adverse ergonomics [1] were the most frequent. This indicates an impact by occupational factors, and linkage to data on occupation would provide extended knowledge. The results were in accordance with a study from the UK [2].

**Keywords:** Epidemiology, Upper limb, Specific health outcomes

### References:

- [1] Van Rijn RM, Huisstede BM, Koes BW, Burdorf A. Associations between work-related factors and specific disorders of the shoulder - a systematic literature review. *Scand J Work Environ Health*. 2010 Jan 22. (Epub ahead of print).
- [2] Linsell L, Dawson J, Zondervan K, Rose P, Randall T, Fitzpatrick R et al. Prevalence and incidence of adults consulting for shoulder conditions in UK primary care; patterns of diagnosis and referral. *Rheumatology* 2006;45:215-21.



## WORK-RELATED PREDICTORS OF MEDICAL CARE-SEEKING WITH NECK AND UPPER EXTREMITY PAIN AND BACK PAIN IN A COHORT OF THE GENERAL WORKING POPULATION

ANDERSEN J.H., JENSEN J.C., HAAHR J.P.

*Department of occupational medicine, Herning, Denmark*

### Aims:

All Danish inhabitants are enlisted with a general practitioner (GP) and data from visits to the GP could be a valuable source for epidemiological studies. The aim of this study was to examine the association between work-related physical and psychosocial factors and medical care seeking with neck and upper extremity pain (UEP) and back pain (BP).

### Methods:

A questionnaire was posted to 8,517 participants, listed with eight GPs, and 5,068 answered, resulting in a response rate on 60%. 4,325 (85%) of those were currently employed and makes up the study group of interest. Physical risk factors were: repetitive work, heavy work and duration of computer work. Psychosocial factors at work were obtained by single item questions on job demands, job control, job satisfaction, and social support from supervisors and colleagues, supplemented by questions on justice and social inclusiveness.

Danish general practitioners are encouraged to code diagnoses according to the Danish version of ICPC, and data on codes for musculoskeletal disorder and/or symptoms were harvested for 18 month after the questionnaires were fulfilled.

We analyzed associations between work-related physical and psychosocial factors and a) care-seeking with neck and upper extremity pain and b) back pain, using logistic regression analysis, adjusting all analyses for gender, age, educational level and work place factors. In a final step we included general health (GH), and mental health (MH) from SF-12 to address if associations were influenced by the general health of the participants.

### Results:

509 (11.8%) participants visited their GP with back pain during 18 month of follow-up. Risk factors for BP patients were heavy work (OR=1.4, 95% CI 1.0-2.1) and low job satisfaction (OR=1.5, 1.0-2.1), and an indication were seen for more care-seeking for participants who rated their work place low on social inclusiveness (OR=1.3, 1.0-1.6).

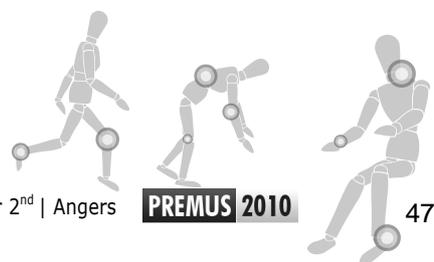
459 (10.6%) made a contact with UEP. Risk factors were age more than 40 yrs (OR=2.0, 1.5-2.6), heavy work (OR=2.3, 1.6-3.3), but not repetitive work or computer work. No significant effects were seen for psychosocial factors.

Inclusion of general health measures (GH and MH) only changed the estimates marginally.

### Conclusion:

Participants in jobs with heavy work tasks had elevated risk for care-seeking for both UEP and LBP, and work modifying procedures could still have an effect in prevention and return to work programs.

**Keywords:** Epidemiology, Back, low back, Upper limb



## ASSESSMENT OF WORK-RELATED MUSCULOSKELETAL DISORDERS USING QUALITY OF WORKLIFE DATA FROM THE 2006 GENERAL SOCIAL SURVEY

WATERS T.R., DICK R.B., KRIEG E.F.

National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA The views expressed in this article are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

### Aims:

Previously reported risk factors using data from the 2002 Quality of Work Life (QWL) survey developed by the National Institute for Occupational Safety and Health (NIOSH) showed significant relationships with exposure to physical and psychosocial factors and symptoms of MSDs (Waters et al., 2007). This paper reports on a follow-on survey that was conducted in 2006 to assess risk factors for work-related musculoskeletal disorders (MSDs) using a similar survey to the one used in 2002, but with a different group of workers.

### Methods:

A national survey, similar to a 2002 survey, used personal interviews to examine individual, psychosocial, and physical factors and their potential relationships to self-reported back pain and upper extremity pain. The survey included questions about back pain, pain in arms, physical factors, individual factors, and psychosocial factors. Statistical analyses were performed to examine relationships between exposure and health outcome variables.

### Results:

Significant relationships were found between physical, individual, and psychosocial factors. Our analysis of the 2006 data reveals that heavy lifting was associated with an increased risk of low back pain, and that repetitive or forceful hand movements was associated with an increased risk of upper extremity disorders. In 2006, all of the psychosocial variables except "Work Fast," "Work Hours" and "Work Schedule" showed a significant relationship to "Back Pain." The only significant individual risk factor for the 2006 data was "Hurt at Work" during the past year. The other individual risk factors, gender and age, did not approach significance. The OR for "Work Stress" and "Pain in Arms" was 4.898 (2.745–8.740), a noticeably stronger effect than observed in the 2002 data analysis.

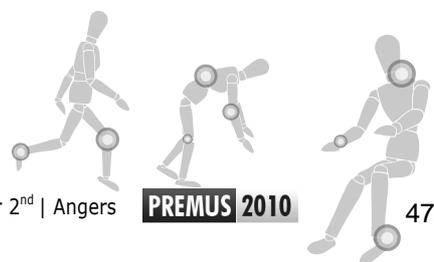
### Conclusion:

Based on our current findings, we conclude that there continues to be a clear relationship between physical loads and musculoskeletal disorders, similar to our conclusions from our analysis of the 2002 data. We also concluded that the results for the analysis of the 2006 data examining the combined effect for physical factors and stress appeared to be additive, for "Back Pain" and "Pain in Arms," which is similar to our findings from analysis of the 2002 data. New strategies for preventing both low back and upper extremity MSDs should focus on work stress, heavy lifting, and hand movement, individually and in combination.

**Keywords:** Epidemiology, Back, low back, Upper limb.

### Reference:

Waters TR, Dick RB, Davis-Barkley J, Krieg EF. A cross-sectional study of risk factors for musculoskeletal symptoms in the workplace using data from the general social survey (GSS). *J Occup Environ Med.* 2007;49:172–184.



## TOWARDS A CONSOLIDATED MEASURE OF THE PHYSICAL, ORGANISATIONAL AND PSYCHOSOCIAL RISK FACTORS FOR WORK-RELATED MUSCULOSKELETAL DISORDERS.

LÄUBLI T.H., MÜLLER C.H., GRAF M.

State Secretary of Economic Affairs SECO, Zurich, Switzerland

### Aims:

A scale is presented that combines physical, organizational and psychosocial risks for work-related musculoskeletal disorders (w-rMSDs) and has proved to be highly predictive.

### Methods:

The analysis was based on the Swiss data from the Fourth European Working Conditions Survey (847 employees, response rate 32%). By interviews information was gathered on working conditions, demographics and work-related health problems.

W-rMSDs were defined as follows: Subjects were asked, if they suffered from any work-related health problems. If yes, a list of possible health problems was presented including low back pain and muscular pain. If the interviewee answered positively to either of these two complaints, then he or she was considered to suffer from w-rMSDs (n=176).

The answers to questions on risk factors for w-rMSDs (n=67) were dichotomized in such a way that, the twenty percent with the most unfavorable working conditions were considered to be at risk. 29 variables were significantly bivcorrelated with w-rMSDs and were entered into a logistic regression model with backward elimination. Variables with a significant contribution to the model were used to create a one-dimensional scale by summing them up (1=risk present; 0=no or moderate risk present).

### Results:

The eight variables that showed a significant effect in the logistic regression model were (Odds Ratios and 95 confidence intervals):

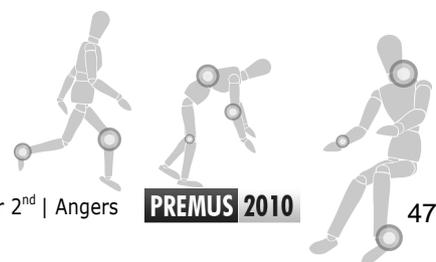
- 1. Poor fit of working hours with family or social commitments 3.4 (2.0–5.6)
- 2. Carrying or moving heavy loads/persons 2.9 (1.7–4.9)
- 3. Exposed to vibrations from hand tools, machinery, etc 2.8 (1.8–4.5)
- 4. Frequent, disruptive tasks 2.3 (1.5–3.4)
- 5. Not very/not at all satisfied with working conditions 2.0 (1.2–3.5)
- 6. Rarely/never assistance from superiors 1.7 (1.1–2.7)
- 7. Pace of work dependent on numerical performance targets 1.7 (1.1–2.5)
- 8. Not free to decide when to take holidays or days off 1.6 (1.1–2.3)

The scale ranged from zero to eight, with seven being the highest value observed (n=4). The scale accurately ( $r^2 = 0.93$ ) predicted the prevalence of w-rMSDs, rising from 2% at scale level 0 until 80% at  $> 4$ .

### Conclusion:

Thus, it seems possible to combine physical, organizational and psychosocial risk factors into a single scale that accurately predicts w-rMSDs. Such a scale should be further investigated as it could be a useful tool for risk assessment at the workplace.

**Keywords:** Surveillance, Methods in epidemiology, Back, low back



## FINNISH WORKERS' OPINIONS ON CONTINUING TO WORK AFTER THE AGE OF 63 AND MUSCULOSKELETAL DISORDERS

PERKIÖ-MÄKELÄ M.M.

*Finnish Institute of Occupational Health, Kuopio, Finland*

### **Aims:**

In Finland, the reform of retirement age legislation came into force in 2005. It offers economic incentives to continue working after the age of 63. The aim of this paper is to present Finnish workers opinions about continuing to work after the age of 63 and find out if the musculoskeletal diseases or disorders are related to these opinions.

### **Methods:**

The study (the Finish National Work and Health Survey 2009) was carried out using a computer-assisted telephone interview (CATI). The study group consisted of 1363 currently working Finns aged 45 to 64.

### **Results:**

One in three (36%) workers said that they will not continue working after 63. Own health (24%); economic reasons, such as salary and better pension (23%); meaningful, interesting and challenging work (20%); lesser work load (16%); flexible working hours or part-time work (15%); good work community (11%) and a good working environment (7%) were stated as the prerequisites to continue working after 63 years of age.

One in ten (10%) had a chronic musculoskeletal disease that affected their work. Long-lasting or repeated work-related musculoskeletal disorders were common. During the last six months 21% have had neck-shoulder pain which was caused by work or which was made worse by work, 15% aching shoulders or arms, 7% aching wrist or fingers, 14% low-back pain and 11% pain in the hips or legs. During the last month 55% have had some (not necessarily work-related) long-lasting or repeated neck-shoulder pain, 38% aching shoulders or arms, 22% aching wrist or fingers, 34% low-back pain and 32% pain in the hips or legs.

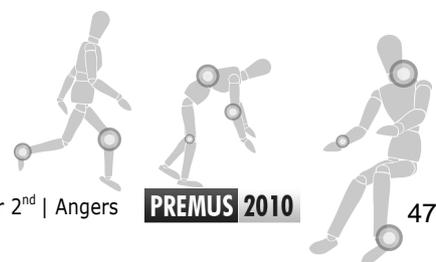
Own health was stated as the prerequisites to continue working after the age of 63 more often (34%) if person had a musculoskeletal disease that affected his/hers work compared to others (23%).

In general lesser work load, flexible working hours and own health was stated as the prerequisite more often if person had some musculoskeletal disorders compared to symptomless. These results will be discussed in detail in the presentation.

### **Conclusion:**

People with musculoskeletal diseases or disorders are worried about their health when predicting continuing at work after the age of 63. Efforts to develop work play an important role if we want to see more people working after 63 years of age.

**Keywords:** Surveillance, return to work, social aspects of MSD



## RISK FACTORS FOR ROTATOR CUFF SYNDROME AND SHOULDER PAIN IN THE WORKING POPULATION

BODIN J.<sup>1</sup>, HA C.<sup>2</sup>, CHASTANG J.F.<sup>3</sup>, DESCATHA A.<sup>3</sup>, LECLERC A.<sup>3</sup>, ROQUELAURE Y.<sup>1</sup>, GOLDBERG M.<sup>2</sup>, IMBERNON E.<sup>2</sup>

<sup>1</sup>Laboratoire d'Ergonomie et d'Épidémiologie en Santé au Travail – Unité associée InVS, Angers, France - <sup>2</sup>Département Santé Travail, Institut de Veille Sanitaire, Saint-Maurice, France - <sup>3</sup>Inserm Unité 687, Villejuif, France.

### Aims:

Using an epidemiological surveillance system for work-related upper-limb musculoskeletal disorders (UE-MSDs) implemented in the France's Pays de la Loire region, the relative importance of personal and work-related factors for rotator cuff syndrome (RCS) and shoulder pain was assessed in the working population.

### Methods:

A total of 3,710 workers (58% men and mean  $\pm$  SD age of  $38.7 \pm 10.3$  years) were included in the surveillance program. UE-MSDs were diagnosed by 83 trained occupational physicians performing a standardized physical examination. The potential risk factors included personal factors, medical history and work history were assessed by a self-administered questionnaire. We used binary logistic regression modelling to determine factors associated with shoulder pain and RCS in working population. Three categories of outcome were defined: no shoulder pain and no RCS (reference), shoulder pain alone, and RCS diagnosed. Only variables significant at 5% were included in final models.

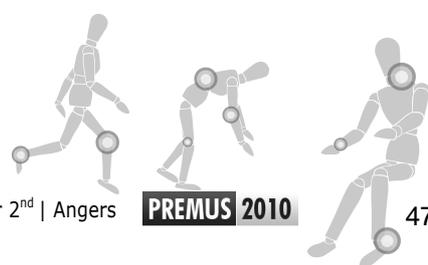
### Results:

The prevalence of RCS was 7.4%, the prevalence of shoulder pain during the preceding 12 months or during the preceding 7 days without RCS was 29.3% and 63.3% has never had shoulder pain. Factors significantly associated with shoulder pain alone in multinomial logistic regressions were gender (OR=1.3 [1.1-1.5]), age (OR=1.4 [1.1-1.8] for 45-49 years with <30 years in reference), prior history of upper-extremity MSDs (OR=2.7 [2.2-3.3]), work pace dependent on automatic rate (OR=1.6 [1.3-2.1]), high physical demand (Borg scale  $\geq 13$ , OR=1.3 [1.1-1.6]), arms abducted (OR=1.5 [1.2-1.9]) and low supervisor support (OR=1.4 [1.2-1.6]). The risk of RCS increased with age ( $p < 0.0001$ ), others factors significantly associated with RCS were prior history of upper-extremity MSDs (OR=5.3 [3.9-7.1]), upper limb inflammatory arthritis (OR=2.9 [1.4-6.0]), high repetitiveness (OR=1.9 [1.4-2.5]), high physical demand (OR=1.7 [1.2-2.3]), arms at or above shoulder level (OR=1.9 [1.3-2.7]) and low supervisor support (OR=1.5 [1.1-2.0]).

### Conclusion:

Personal and work-related biomechanical and psychosocial factors were associated with both shoulder pain and RCS. Work organisation was more related to shoulder pain whereas individual factors, namely age and history of upper-extremity MSDs, were more associated with RCS.

**Keywords:** Work organization, personal risk factors for MSD, epidemiology



## POPULATION ATTRIBUTABLE RISK OF LUMBAR DISC SURGERY ACCORDING TO OCCUPATION: A STUDY IN A FRENCH GENERAL POPULATION

FOUQUET N.<sup>1,2</sup>, ROQUELAURE Y.<sup>2</sup>, HA C.<sup>1</sup>, BORD E.<sup>3</sup>, SURER N.<sup>3</sup>, PETIT LE MANAC'H A.<sup>2</sup>, LECLERC A.<sup>4</sup>, LOMBRIL P.<sup>3</sup>, GOLDBERG M.<sup>1</sup>, IMBERNON E.<sup>1</sup>

<sup>1</sup> Department of Occupational Health DST, French Institute for Public Health Surveillance InVS, Saint-Maurice - <sup>2</sup> Laboratory of Ergonomics and Epidemiology in Occupational Health LEEST, University of Angers, IFR 132, UPRES 4336, UNAM, University Hospital of Angers - <sup>3</sup> Pole Neurosciences, University Hospital of Nantes; PIMESP, University Hospital of Nantes - <sup>4</sup> INSERM, U687, Villejuif, France.

### Aims:

Disc-related sciatica represents one of the most significant and costly health problems occurring in the working population. The aim of this study was to assess the work-related population attributable fraction (PAF) of lumbar disc surgery (LDS) for disc-related sciatica in occupational categories at high risk in the general population.

### Methods:

Patients living in a French region in 2003 and discharged from a large University Hospital following LDS were compared with demographic and socioeconomic data from the population census. Medical and occupational histories from 75 women and 71 men were gathered using a mailed questionnaire. The age-adjusted relative risks and PAF of CTS were calculated according to occupational categories.

### Results:

The PAFs of lumbar disc surgery was 37% [19-54] for the male blue-collar workers suggesting that about 37% of the cases occurring in this category of workers could be avoided if the excess risk of LDS could be eliminated. The PAF value for male and female lower-grade white collar workers and female intermediate occupations were 18%, 33% and 13%, respectively.

**Table. Age-adjusted relative risks and population attributable risk fractions of lumbar disc surgery (PAF) according to occupation category in the general population #**

	Pe (%)	n	Age-adjusted RR [CI95%] <sup>a</sup>	PAF (%) [range] <sup>b</sup>
<b>Women</b>				
1. Farmers	1.1	0	-	-
2. Craftswomen, saleswomen and managers	2.4	0	-	-
3. Professionals	5.3	7	1.9 [0.9-4.1]	-
4. Technicians, associate professionals <sup>§</sup>	15.7	16	2.6 [1.5-4.8]	13 [1-28]
43. Intermediate occupations in health and social work	4.5	7	2.9 [1.3-6.5]	66 [58-72]
46. Intermediate occupations in administrative and commercial companies	5.0	5	4.6 [1.5-14.2]	78 [73-82]
5. Lower-grade white-collar workers	32.5	42	2.5 [1.5-4.0]	33 [15-50]
52. Employees of government and public services	11.1	17	2.9 [1.7-5.2]	66 [58-73]
55. Trade and commerce employees	4.1	6	3.9 [1.6-9.1]	74 [68-79]
56. Personal service employees	7.9	11	2.5 [1.3-4.8]	60 [51-67]
6. Blue-collar workers	6.5	7	2.0 [0.9-4.5]	-
<b>Men</b>				
1. Farmers	2.5	0	-	-
2. Craftswomen, saleswomen and managers	6.2	6	2.4 [1.0-5.8]	-
3. Professionals	11.8	7	1.1 [0.5-2.5]	-
4. Technicians, associate professionals <sup>§</sup>	18.8	7	0.6 [0.3-1.4]	-
5. Lower-grade white-collar workers	8.3	8	3.6 [1.6-8.5]	18 [5-38]
6. Blue-collar workers	30.5	39	2.9 [1.8-4.9]	37 [19-54]
62. Skilled manufacturing workers	8.8	11	2.2 [1.1-4.3]	55 [45-63]
63. Skilled small-scale workers	7.8	5	2.8 [1.1-7.5]	65 [57-71]
64. Drivers	3.4	8	4.8 [2.3-10.3]	79 [74-84]
67. Unskilled manufacturing workers	5.1	9	5.0 [2.2-11.4]	80 [75-84]

# Patients employed during the five last years before lumbar disc surgery (72 women and 67 men); Pe (%): percentage of the general population of the region in this occupation; <sup>a</sup> RRs were computed when at least five cases were diagnosed, with the whole sample of subjects professionally active or not during the year before lumbar disc surgery as reference group; 95% confidence interval; <sup>b</sup> This range was computed using the lower and higher limits of the confidence interval of the RR of CTS in the equation; <sup>§</sup> Technicians and associate professionals perform mostly technical and related tasks and teach at certain educational levels. Most occupations in this group require skills at the third ISCO level (education which begins at the age of 17 or 18 years and leads to an award not equivalent to a first university degree).

### Conclusion:

The study suggested that 13–37% of LDS for disc-related sciatica might be avoided in the whole population if totally effective intervention programs were implemented in specific occupational categories or industries. However, these preliminary findings must be confirmed by a larger study conducted in the whole region to assess more accurately the proportion of avoidable cases of LDS in the population.

**Keywords:** Surveillance, Epidemiology, Back, low back



## ECONOMIC SECTORS AND OCCUPATIONS AT RISK FOR THE DEVELOPMENT OF LUMBAR SPINE DISEASES – RESULTS OF THE GERMAN SPINE STUDY

MICHAELIS M., HOFMANN F., BOLM-AUDORFF U., BERGMANN A., DITCHEN D.M., ELLEGAST R.P., ELSNER G., GRIFKA J., HAERTING J., JÄGER M., LINHARDT O., LUTTMANN A., PETEREIT-HAACK G., SEIDLER A.

Research Centre for Occupational and Social Medicine (FFAS), Freiburg, Germany

### Aims:

The multi-center case-control study „German Spine Study EPILIFT” was aimed to estimate the dose-response relationship between occupational exposure to physical loads and lumbar diseases(1). Here results will be presented in which occupations or economic sectors, respectively, patients are over-represented compared to the general population (2).

### Methods:

The occupation data of 915 cases with clinically diagnosed disc herniation or osteochondrosis in the lumbar spine and of 901 population controls (51±12 and 47±12 years of age, respectively, 884 men, 932 women) were analyzed with regard to economic sectors and occupational sections. The occupational history took place using standardized computer-assisted interviews. Individual's job-specific years of exposure were cumulated and odds ratios (OR, with 95% CI) for „ever worked” and ”worked at least ten years” were analyzed. Results were standardized by age, gender and study center.

### Results:

Among some of the economic sectors attributed to extended spinal load increased risks (OR ≥ 1.5) were found; among other sectors the risk is just below. In the transport/communication, in the construction industry (men, both OR= 1.5, CI 1.1–2.2/1.1–2.1 and in the hotel/restaurant sector (women, OR= 1.6, CI 1.1–2.4), the results are statistically significant. In the category „occupational sections”, increased risks were found among most, but not all of the groups considered as exposed; the results were statistically significant in the case of male traffic occupations (OR = 1.5, CI 1.1–2.2) and of female sale occupations (OR = 1.5, CI 1.1–2.0). Results appearing implausible were relativized by more detailed analysis (e.g. nurses, OR = 1.3). A time-related dose-response relationship (occupation for at least ten years) could also be verified in some, but not in all categories with a sufficient number of cases. Significant results were found only in male bus and truck drivers (OR = 1.9, CI 1.2–3.1).

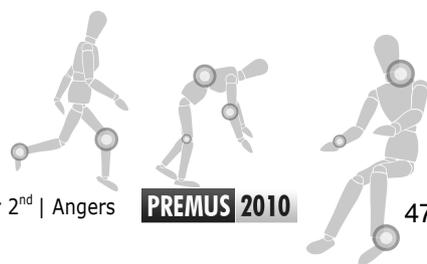
### Conclusion:

The results confirm increased risks in a couple of the occupations, which are well-known for being exposed to disc-related lumbar spine diseases from former epidemiological studies. The missing plausibility especially in several heterogeneous categories of occupational sections are leading to the conclusion that risk assessment based on occupational data should be as specifically as possible; those based on working activities and postures seem to be more reasonable, especially in view of diverse occupational biographies nowadays.

**Keywords:** Exposure measurement methods, Epidemiology, Back, Low back

### References:

Seidler A, Bergmann A, Jäger M, Ellegast R, Ditchen D, Elsner G, Grifka J, Haerting J, Hofmann F, Linhardt O, Luttmann A, Michaelis M, Petereit-Haack G, Schumann B, Bolm-Audorff U. Cumulative occupational lumbar load and lumbar disc disease--results of a German multi-center case-control study (EPILIFT). *BMC Musculoskelet Disord*. 2009 May 7;10:48. DOI10.1186/1471-2474-10-48  
Michaelis M, Hofmann F, Bolm-Audorff U, Bergmann A, Ditchen D, Ellegast R, Elsner G, Grifka J, Haerting J, Jäger M, Linhardt O, Luttmann A, Nübling M, Petereit-Haack G, Seidler A. Risikobranchen und -berufe für die Entwicklung bandscheibenbedingter Erkrankungen der Lendenwirbelsäule – Ergebnisse der Deutschen Wirbelsäulenstudie [Economic sectors and occupations at risk for the development of lumbar spine diseases – Results of the German Spine Study]. *Zentralblatt für Arbeitsmedizin, Arbeitsschutz und Ergonomie* 57 (2007), 277-286. [www.dguv.de/ifa/de/fac/ergonomie/dws/index.jsp](http://www.dguv.de/ifa/de/fac/ergonomie/dws/index.jsp) (accessed January 2010)



## MUSCULOSKELETAL DISORDERS SUBJECTIVELY ENHANCE THE COOLING INDUCED DECREASE IN MENTAL AND FINE MOTOR PERFORMANCE

PIENIMAKI T., RINTAMÄKI H., NAYHA S., LAATIKAINEN T.

*Finnish Institute of Occupational Health, Finland*

### **Aims:**

Cooling impairs muscular performance and possibly also mental and fine motor performance. Subjects with a musculoskeletal disease (MSD) seem to have an increased sensitivity to cold sensations and cold-related pain. Therefore, it is worth of investigating the possible cold-related functional loss in mental and fine motor performance in subjects with MSD.

### **Methods:**

This study was a part of National Finrisk 2002 population-based survey of 13,437 subjects. Cold exposure questionnaire was sent to a random sample (n=10,256). The respondents were asked to estimate following forms of their performance in cold: mental concentration, mental performance, hand dexterity, tactile sensitivity and motor co-ordination.

The effects of cold exposure on performance were classified in 3 groups: 1) improved or unchanged performance, 2) decreased performance due to cooling and 3) decreased performance due to symptoms. Multinomial regression analysis was used to analyse the factors associated with performance changes caused by cold exposure. The performance changes were analysed in relation to leisure time physical activity (PA), workload, body mass index (BMI), self-rated physical fitness, musculoskeletal pain (MSP), physician diagnosed musculoskeletal disorders (MSD) and use of medication.

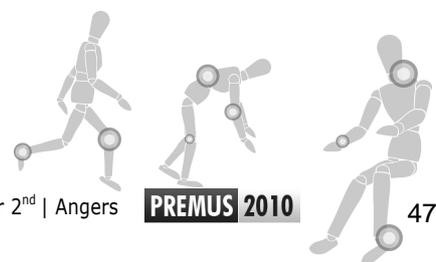
### **Results:**

From responded 5879 subjects 2566 were healthy, 2042 had MSPs without a MSD, 692 had a back disorder (BD), 498 a joint disorder (JD) and 81 rheumatoid arthritis (RA). The 5 performance forms were reported to be improved or unchanged in 34-85% of subjects, decreased due to cooling in 12-57% and decreased due to emerging symptoms in 3-10%. The decreases were highest in hand dexterity and lowest in mental tasks. Reported physician diagnosed MSDs in spite of RA, reported MSPs, use of antidepressive medication and poor self-rated physical fitness were highly associated with cold-induced decrease in mental concentration and mental tasks, tactile sensitivity, hand dexterity and motor co-ordination both due to cooling or emerging symptoms (p for all  $< 0.05$  associated with better performance in cold but high level PA not).

### **Conclusion:**

Subjects with a diagnosed MSD or with MSP experience enhanced decrease in mental performance, tactile sensitivity, manual dexterity and motor co-ordination due to cold and may be more vulnerable to cold. High BMI can protect from the performance loss, unlike high level of PA. Workers having MSD or MSP in tasks requiring good mental and fine motor performance need special attention in cold-exposed work.

**Keywords:** Specific sectors, epidemiology, vulnerable workers



## LIFESTYLE AND METABOLIC FACTORS IN RELATION TO SHOULDER PAIN AND ROTATOR CUFF TENDINITIS: A POPULATION-BASED STUDY

RECHARDT M., SHIRI R., KARPPINEN J., JULA A., HELIÖVAARA M., VIKARI-JUNTURA E.

*Finnish Institute of Occupational Health, Finland*

### **Aims:**

We studied the associations of lifestyle and metabolic factors and carotid intima-media thickness with shoulder pain and chronic rotator cuff tendinitis in the Finnish general population.

### **Methods:**

The original sample consisted of 8,028 subjects aged 30 years or over and 6,354 (79.7%) participated in the clinical examination.

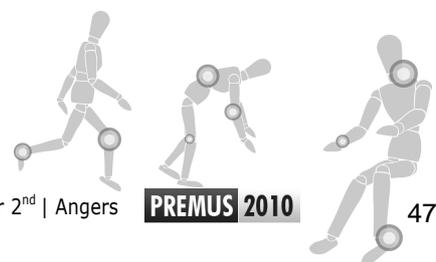
### **Results:**

The one month prevalence of shoulder pain was 16% and that of chronic rotator cuff tendinitis 2.8%. Heavy smoking, waist circumference and waist-to-hip ratio were related to an increased prevalence of shoulder pain in both genders. Metabolic syndrome, type 2 diabetes and carotid intima-media thickness were associated with shoulder pain in men, whereas insulin resistance and high C-reactive protein were associated with shoulder pain in women. Increased waist circumference and type 1 diabetes were associated with chronic rotator cuff tendinitis in men.

### **Conclusion:**

Our findings showed the associations of abdominal obesity, other metabolic factors and carotid intima-media thickness with shoulder pain. Disturbed glucose metabolism and atherosclerosis may be the underlying mechanisms. Our findings suggest that preventive measures for cardiovascular disease may be useful in the prevention of shoulder pain.

**Keywords:** Personal risk factors for MSD, epidemiology, upper limb



## GENDER DIFFERENCES

### EXPOSURE-RESPONSE RELATIONSHIPS FOR WORK-RELATED MUSCULOSKELETAL DISORDERS IN ELBOWS AND HANDS

NORDANDER C., OHLSSON K., ÅKESSON I., ARVIDSSON I., BALOGH I., HANSSON G.Å., STRÖMBERG U., RITTNER R., SKERFVING S.

*Occupational and Environmental Medicine, University Hospital, Lund, Sweden*

#### Aims:

Intense manual work tasks with rapid hand/wrist movements represent an increased risk of elbow and hand disorders; however the quantitative exposure-response relationships are largely unknown. As females have more musculoskeletal disorders than males, even in identical work tasks, such relationships should be defined separate for genders. Movement velocity is difficult to observe, technical measurements on the other hand give objective quantitative and generic information of exposure, on continuous scales [1]. Our research group has collected data on disorders, and on wrist velocity, in many different jobs with large contrasts in physical exposure (median wrist velocity ranging from 2 to 41°/s). The aim was to compile these data to describe gender specific exposure-response relationships between wrist velocity and disorders in elbows and hands.

#### Methods:

Nineteen female (1891 workers) and 8 male (761) occupational groups were included. In each group, movements of the right wrist were registered by biaxial goniometers (sampling rate 20 Hz) in a subgroup of workers, to obtain a representative group mean. In all registrations were performed in 341 females and 82 males). The 50th percentiles of the absolute angular velocity distributions were derived [2]. Pain or discomfort in the right elbow and hand during the past 12 months, as well as the past 7 days, were recorded by the Nordic Questionnaire among all subjects in each group [3]. For the mean prevalences, linear regressions on the group means of the wrist velocity were performed, weighted by the number of subjects in each group. Analyses were made for females and males separately, and in bivariate models including genders, tested for interaction by gender.

#### Results:

Statistically significant relationships were shown for the last 12 months (females  $\beta = 0.88\%/(\text{°/s})$ ,  $p=0.001$ ; males  $\beta = 0.95\%/(\text{°/s})$ ,  $p=0.05$ ) as well as for the last 7 days (females  $\beta = 0.61\%/(\text{°/s})$ ,  $p=0.006$ ; males  $\beta = 0.64\%/(\text{°/s})$ ,  $p=0.02$ ). No interaction by gender was shown, but there was a gender difference of 9.9% ( $p=0.05$ ) and 9.2% ( $p=0.02$ ) respectively, with higher prevalences for females.

#### Conclusion:

An increase in wrist velocity of 10 °/s increases the prevalence of experienced pain or discomfort during the last week with 6% among females as well as males. Such knowledge is powerful for prevention in work task design and could be used for decisions on precise quantitative regulatory standards.

**Keywords:** Exposure measurement methods, Gender differences, Upper limb

#### References:

- [1] Hansson G-Å, Balogh I, Ohlsson K, Rylander L, Skerfving S. Goniometer measurements and computer analysis of wrist angles and movements applied to occupational repetitive work. *J Electromyogr Kinesiol* 1996;6:23-35.
- [2] Hansson G-Å, Balogh I, Ohlsson K, Granqvist L, Nordander C, Arvidsson I, Åkesson I, Unge J, Rittner R, Strömberg U, Skerfving S. Physical workload in various types of work; part I: wrist and forearm. *International Journal of Industrial Ergonomics*. 2009;39:221-33.
- [3] Nordander C, Ohlsson K, Åkesson I, Arvidsson I, Balogh I, Hansson G-Å, Strömberg U, Rittner R, Skerfving S. Risk of musculoskeletal disorders among females and males in repetitive/constrained work. *Ergonomics*. 2009;52:1226-39.



## **GENDER DIFFERENCES IN COMPUTER USE, MUSCULOSKELETAL SYMPTOMS AND PERCEIVED STRESS AMONG YOUNG ADULT STUDENTS**

GUSTAFSSON E., LÖVE J., THOMÉE S., EKMAN A., AHLSTRAND C., HAGBERG M.

*Occupational and Environmental Medicine, University of Gothenburg, Gothenburg, Sweden*

### **Aims:**

The aim of this study was to determine whether there were gender differences in the use of information and communication technology (ICT), musculoskeletal symptoms and perceived stress among young adult students.

### **Methods:**

In a Swedish cohort of 2914 students (1363 women, 1551 men) aged 18-25 years, from different university program selected to represent different kinds and amount of ICT use, they were asked to fill out a web based survey with questions about their use of information and communication technology (both school and leisure time), musculoskeletal symptoms and perceived stress.

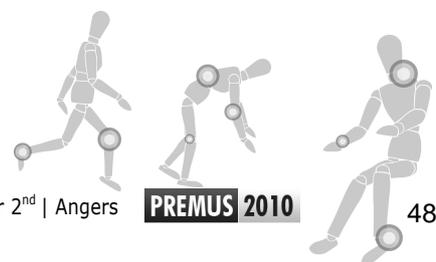
### **Results:**

The male students reported twice as many hours per week with computer use (20 hours/week) compared to the female students (10 hours/week), while the female students reported longer time of mobile phone use (3.2 hours/week) compared to the male students (2.7 hours/week). 17% of the male students reported longer use of computers without pauses (>4 hours without pauses longer than 10 minutes) more than 5 times/week compared to 5% of the female students. Most of the students reported rather good or good perceived over all health (79% of the females, 82% of the males) but 27% and 14% respectively of the female students reported ongoing musculoskeletal symptoms from the neck and the upper extremities compared to 12% and 9% respectively of the male students. 13% of the females reported reduced productivity due to their musculoskeletal symptoms compared to 8% of the males and twice as many of the female students (30%) perceived rather high or very high stress compared to the males (16%).

### **Conclusion:**

In conclusion the male students used their computers twice as long per week as the females while more of the female students reported rather high and high perceived stress as well as musculoskeletal symptoms from the neck and/or upper extremities compared to the male students.

**Keywords:** Computer work, Gender differences, Upper limb



## SEX DIFFERENCES IN NECK AND SHOULDER STRENGTH, MUSCLE ACTIVITY AND RESPONSES TO FATIGUE AND PAIN: POSSIBLE LINKS WITH WMSD?

CÔTÉ J.N., RIVEST K., FULLER J.R., PEARSON I., EMERY K., LOMOND K.V., DE SERRES S.J., DUMAS J.P.

McGill University, Montreal; Michael Feil and Ted Oberfield/CRIR Research Centre, Jewish Rehabilitation Hospital, Laval, Canada

### Aims:

It is well documented that women are more likely to report work-related neck-shoulder pain than men. Although some work-related aspects have been identified as possible determinants for this sex difference, information about neck-shoulder related differences between sexes is lacking, and is needed in order to identify the biopsychosocial pathways underlying these differences. This abstract summarizes results of several laboratory studies undertaken to assess sex differences in neck-shoulder strength, muscle activity, and responses to fatigue and pain among groups of healthy participants and others with neck-shoulder pain.

### Methods:

In the first group of studies, sex-matched groups of healthy participants or with chronic neck-shoulder pain completed a repetitive reaching task (RRT) to fatigue, the dominant arm moving at shoulder height (Fuller et al., 2009) while we recorded activity of the trapezius muscle on the reaching side. Before and after fatigue, we measured shoulder elevation strength and arm power (BTE-Technologies) and endpoint and shoulder position sense by having subjects, eyes closed, move to memorized targets in the workspace. In the second study, we compared neck strength between sex-matched groups of healthy participants and others with neck pain (Pearson et al., 2009). In the third study, we measured change in pain threshold and catastrophizing from acute (4 weeks) to chronic (1 year) stages of neck pain (Rivest et al., 2009).

### Results:

Results show that men have higher neck strength (+34-49%), arm power ( $P = 0.008$ ) and upper trapezius muscle activity, and higher shoulder elevation strength ( $P = 0.033$ ) before fatigue but not after fatigue ( $P = 0.084$ ). There were no sex differences in the time to fatigue (~8min), in the effect of fatigue on muscle activity or in position sense before or after fatigue. In sex subgroups with similar neck pain and disability, pressure pain thresholds were always higher in men, and improved outcome with time was associated with improvements in pain thresholds in women but with catastrophizing in men.

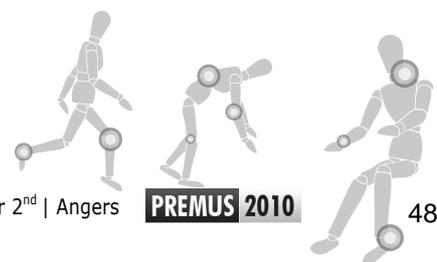
### Conclusion:

Taken together, results suggest that even though pre-fatigue strength is higher in men, repetitive motion-induced fatigue affects men and women in biomechanically similar fashions. However, sex differences in pain-related sensory and/or perceptual aspects suggest that part of the mechanisms of WMSD could be sex-specific. This information could be useful in designing more effective prevention, rehabilitation and return-to-work programs.

**Keywords:** Gender differences, Neck, Upper limb

### References:

- Fuller J, Lomond KV, Fung J, Cote JN. Posture-movement changes following repetitive motion-induced shoulder muscle fatigue. *J Electromyogr Kinesiol.* 2009;19(6):1043-52.
- Pearson I, Reichert A, De Serres SJ, Dumas JP, Cote JN. Maximal voluntary isometric neck strength deficits in adults with whiplash-associated disorders and association with pain and fear of movement. *J Orthop Sports Phys Ther.* 2009;39(3):179-87.
- Rivest K, Cote JN, Dumas JP, Sterling M, De Serres SJ. Relationships between pain thresholds, catastrophizing and gender in acute whiplash injury. *Man Ther.* 2009; doi:10.1016/j.math.2009.10.001.



## GENDER DIFFERENCES IN OCCUPATIONAL DISC-RELATED DISEASES OF THE LUMBAR SPINE CAUSED BY LIFTING, CARRYING OR EXTREME TRUNK FLEXION IN GERMANY

LATZA U., SEIDLER A., LIEBERS F.

Federal Institute for Occupational Safety and Health, Berlin, Germany

### Aims:

Low back disorders are recognized as occupational diseases (OD) in some countries

1. In Germany OD No. 2108 defines disc-related diseases of the lumbar spine caused by long-term lifting or carrying of heavy loads or work in an extreme bent posture
2. Reporting is compulsory for physicians
3. Recognition requires a favourable medical expert opinion. Gender specific analyses of this OD are presented in order to identify potentials for prevention, quality control, and research needs.

### Methods:

Cumulative figures of the German Social Accident Insurance for the Industrial and Public Sectors (DGUV) for a 10-year period are stratified by gender and other variables (DGUV Referat BK-Statistik/ZIGUV D-53757 Sankt Augustin of 12/18/09).

### Results:

During 1999-2008 the DGUV received 76,576 reports (74.1% men and 25.9% women) of a suspected OD No. 2108 and recognized 3,484 cases (47.4% men and 52.6% women). Most recognized cases of men and women were reported by medical doctors followed by insured individuals and health insurances. Among men 26.5% of cases came from the statutory health insurances as compared to 22.2% among women. Cases from institutions for non-public health care and welfare providers (220 male and 1,584 female cases) and the construction industry (471 male and 5 female cases) dominated. The most frequent diagnoses were disc prolapse (63.3% among males and 44.0% among females) and back pain (16.9% among males and 34.2% among females). Bricklayers among men and nurses among women were predominately affected. Patient transfers (222 male and 1,477 female cases) and extreme trunk flexion (493 male and 200 female cases) were the main identified causes. The most frequent age category at diagnosis was 60-<65 years in men and 45-<50 years in women. The predominant categorized duration of exposure was 25-<30 years among men and 15-<20 years among women.

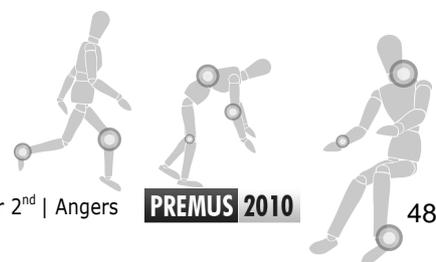
### Conclusion:

Legal regulations and administrative procedures in Germany lead to a comparatively low recognition rate of disc related diseases of the lumbar spine caused by lifting, carrying or extreme trunk flexion. Affected women tended to be younger, had shorter exposure, and often came from the health care sector as compared to men who mainly came from the construction sector. The observed gender differences probably partly reflect gender-specific career choices and inhomogeneous administrative procedures within different statutory accident insurance institutions. In both genders few cases were reported by medical doctors as compared to other ODs. Reporting by health insurances, particularly among men, is the most obvious indication for potential in quality assurance.

**Keywords:** Surveillance, Gender differences, Back, low back

### References:

European Commission. Population and social conditions: European occupational diseases statistics (EODS). Phase 1 methodology. Luxembourg: European Commission 2000. Doc. OS/E3/HSW/2000/1081 [ec.europa.eu/social/BlobServlet?docId=3153&langId=en]  
Federal Institute for Occupational Safety and Health. List of occupational diseases (as contained in the annex to the German ordinance on occupational diseases of 01.10.2002). [http://www.baua.de/nn\_69456/en/Topics-from-A-to-Z/Occupational-Diseases/pdf]  
Latz U, Baur X. Occupational obstructive airway diseases in Germany: Frequency and causes in an international comparison. Am J Ind Med. 2005;48:144-152.



## SERIOUS PAIN RELATED TO STATIC WORK IS TWICE AS FREQUENT IN FEMALE DENTISTS AS IN MALE DENTIST

PROTEAU R.A  
ASSTSAS, Canada

### Aims:

For the past 10 years, ASSTSAS has been involved in the evaluation of dentist, dental hygienist and dental assistants who consulted us for serious pain in various part of they body. The objective was to know the frequency of serious pain in dental personnel

### Methods:

Participants to a continuing education activity on the Prevention of musculoskeletal disorders in dental clinics for its members in 15 Quebec regions, were asked to fill out a questionnaire before the meeting started and to return it before they left. This course was recognized by the Ordre des dentistes du Québec [Quebec Order of Dentists] for six credit hours of continuing education. In some parts of the provinc,e dentists invited their staff to the sessions, while in others , they didn't. The three-page questionnaire included a schematic drawing of the body indicating the various problem areas to be identified. The question was: "In the past 12 months, have you experienced serious pain in any part of your body that interfered with your usual activities?" Of the 1,138 participants, 687 (60%) handed in a completed questionnaire: 258 male dentists, 201 female dentists, 108 dental hygienists, and 77 dental assistants. The respondents in all job categories worked an average of 32 hours a week.

### Results:

For serious pain "quite often" or "all the time", female dentists have approximately twice as much pain (30% to 36%) as male dentists (14 to 18%) in the neck, shoulders and upper back (statistically significant  $p < 0.001$ , when compared with chi square). Female and male dentists do similar work. The level for static work that is considered safe of long duration is 5% of maximum strength (Bjoksten et al, 1977). The fact that men have greater strength probably allows them to reduce the percentage of maximum force required to hold the arms and neck in a static position. A study of dental hygienists (Proteau et al., 2001) showed that under regular working conditions, the

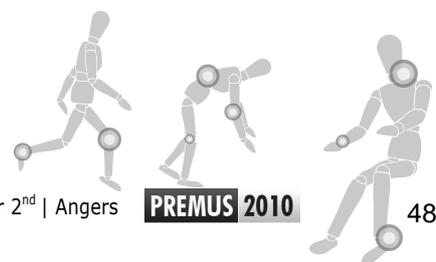
### Conclusion:

Female workers have advantage to reduce their level of static work. Reducing static load on the shoulder girdle seems to be particularly important for female dentists and d

**Keywords:** Muscle activity, gender differences, neck

### Reference:

BJÖKSTEN, M. & JONSSON, B. "Endurance Limit of Force in Long-Term Intermittent Static Contractions". Scandinavian Journal of Work Environment and Health 3, 1977, pp 23-27.



## **GENDER INVOLVEMENT IN MANUAL MATERIAL HANDLING (MMH) TASKS IN AGRICULTURE AND RESULTING MUSCULOSKELETAL DISORDERS.**

SINGH S., RATHORE H., SINWAL N.

College of home science, Maharana Pratap University of Agriculture and Technology, Udaipur, India.

### **Aims:**

Agriculture is an occupation framed within the context of family and community in India. A considerable number of adverse health conditions, including musculoskeletal disorders, are linked to agricultural work. The lifting and carrying of loads in agriculture on small landholdings are unavoidable. Objectives: 1. To study gender participation in agricultural activities involving manual material handling tasks. 2. To assess Musculo-Skeletal Disorders (MSDs) experienced in various manual material handling tasks.

### **Methods:**

The present study was conducted in villages of Rajasthan in INDIA. A sample of 100 agricultural workers (50 male and 50 female) engaged in agricultural tasks from last 10 years were selected to assess Musculo-Skeletal Disorders (MSDs) experienced. Assessment of MSDs in Manual Material Handling (MMH) tasks was done using psycho-physical method viz., Body Map and Visual Analogue Discomfort (VAD) Scale.

### **Results:**

Majority of the female carried fuel wood, grain to flour mill, fodder, animal dung and dung cakes. In agriculture female respondents played a key role in MMH tasks in land preparation, manuring, sowing, fertilizer broadcasting. Both the genders were equally involved in MMH tasks of harvesting and threshing. The Body Part Discomfort Score of the respondents for household and animal husbandry task indicated that both the male and female respondents felt chronic pain in neck and shoulder while performing all the household tasks whereas in animal husbandry tasks they felt chronic pain during water and fodder carrying tasks. The Body Part Discomfort Score of the respondents for all agriculture activities except weeding task indicated greater susceptibility of females to musculo skeletal problems. (Table-1)

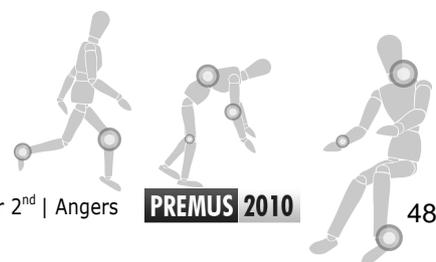
### **Conclusion:**

The results indicated greater susceptibility of females to musculo skeletal problems in most of household, animal husbandry and agriculture involving MMH. The Overall Discomfort Rating (ODR) score revealed that all the agricultural tasks brought risks to the workers and need timely precautions.

**Keywords:** Musculoskeletal problems, Workplace response, Chronic pain

### **References:**

- Corlett, E.N. and Bishop, R.P. 1976. A technique for assessing postural discomfort. *Ergonomics* 19:175-192.  
Ergoweb Inc. 2001. The ergonomics of manual material handling. Cited from [www.conveyercaster.com](http://www.conveyercaster.com).  
Farley, 1995. Cited by Vyas, R. and Singh, S. 2006. Occupational Health Hazards among Agricultural Workers and Developing Educational Aids for Creating Awareness. Unpublished Ph.D. Thesis. Deptt. of FRM, College of Home Science, MPUAT, Udaipur.



## WORK IN FORWARD BENT POSITION IN ASSISTANT NURSES

AHLGREN C., WAHLSTRÖM J.

*Dept Community Medicine and Rehabilitation, Physiotherapy, Dept Public Health and Clinical Medicine, Occupational and Environmental Medicine, Umeå University, Umeå, Sweden*

### **Aims:**

To analyze within and between subject variability among assistant nurses for time duration and frequency of work postures with the trunk in a forward bent position and to compare measurement data with self-reported data

### **Methods:**

Fifteen assistant nurses (9 women and 6 men) working in geriatric wards were recruited. Mean age was 34 year and work experience varied between 1 month and 38 years. Work postures were measured during whole work shifts on four consecutive shifts. After each work shift the assistant nurse rated duration and frequency of work with the trunk forward bent more than 45 degrees. The 45 degree position was showed on a figure. For objective measurements of work posture a Virtual Corset was used. Virtual Corset, consists of an accelerometer and a data logger. The accelerometer registers the persons' trunk position relative to the gravity line with a frequency of 7.5 Hz and can be used for whole day measurements. In the analysis, total time with the trunk forward bent more than 45 degrees for all measurements was used as group mean. Frequency of forward bending was divided into short duration bendings (less than 5 seconds) and long duration bendings (5 seconds or longer). For each assistant nurse data for each day as well as an individual mean for all four days was calculated and used in the calculations of the within and between individual variation.

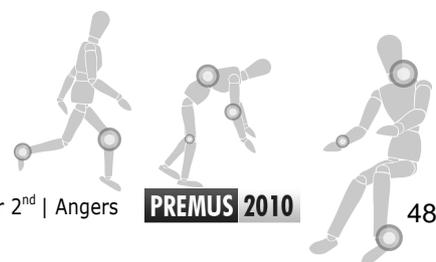
### **Results:**

Group mean time with the trunk forward bent more than 45 degrees, was less than 4% of the total working time with an individual variation between 0.5 and 8.5%. Female assistant nurses tended to be in the forward bent position longer than male nurses. The mean frequency of forward bending more than 45 degrees during a work shift was 410 times with an individual variation between 228 and 1130 times. A majority of the bendings were of short duration. Correlation between measurement data and self reports was low both for duration and frequency with correlation coefficients 0.13 and 0.4 respectively. Duration of time in forward bent position was both over and underestimated and frequency of forward bending was always underestimated.

### **Conclusion:**

Both duration and frequency of work in forward bent position varies extensively between employees at the same work place. Self-reports on work exposure in forward bending are unreliable both regarding duration of time and frequency

**Keywords:** Postures, physical exposure, exposure measurement methods, gender differences



## A STUDY OF GENDER-BASED WORK ORGANIZATION AMONG SANITATION AND MAINTENANCE EMPLOYEES AT A QUÉBEC HOSPITAL

CALVET B., RIEL J., MESSING K.

*Cinbiose, UQAM, Montréal, Canada*

### **Aims:**

Studies done by our research team in 1994-95 in hospitals show that jobs related to cleaning services were then assigned as “heavy” work for men and “light” work for women. Our more recent study (2006-07) was done in the context of formal merging of ‘heavy’ and ‘light’ work for assignment to both men and women. We note an overall decrease in the number of women working in this sector, and we ask whether a gender-based segregation of labour remains among women who are employed in this sector. The objective of this study is to analyze the time spent by each gender on formerly “heavy” or “light” work as well as the difficulties encountered in this work according to gender.

### **Methods:**

A questionnaire that included health-related questions, including a Nordic-type body map, and employee perceptions of merged ‘heavy’ and ‘light’ work was administered to 30 men and 16 women. During the following months, work and working conditions of 10 male and 3 female volunteers was observed for a total of 70 hours. Interviews were then held with 6 male and 9 female volunteers.

### **Results:**

By comparing the activity of men and women who were assigned similar work we found that men spend more time doing activities formerly defined as ‘heavy’ work, while women spend more time in ‘light’ work. Both before and after the work re-organisation, women reported more MSDs in the upper limbs and men in the back. This could be attributed to the differential time apportionment.

Women work preferentially on the day shift where they clean areas that are occupied by patients and health care workers; this involves cognitive demands that are absent on the evening shift where men tend to clean empty offices. In the hospital, even after merging of job titles, there remain tasks to which women are not assigned because of the heavy physical demands. Some highly selected men accomplish these tasks and are exposed to the consequent risks.

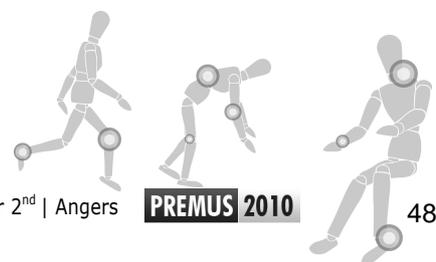
### **Conclusion:**

We conclude that a gender-based division of labour remains despite attempts to merge ‘heavy’ and ‘light’ work. The health consequences for the workers may be related to the gender segregation of tasks. Sudden desegregation of previous sex-typed assignments in physically demanding work cannot be done without examination and adaptation of work environments, equipment and training.

**Keywords:** Specific sectors, work organization, gender differences

### **References:**

- Messing, K., Chatigny, C., Courville, J. (1996). L'invisibilité du travail et la division léger/lourd dans l'entretien sanitaire: Impact sur la santé et la sécurité du travail. *Objectif Prévention*, 19(2), 13-16.
- Messing, K. (1998). Hospital trash: Cleaners speak of their role in disease prevention. *Medical Anthropology Quarterly*, 12 (2.), 168-187.
- Messing, K., Chatigny, C., Courville, J. (1998) “Light” and “heavy” work in the housekeeping service of a hospital. *Applied Ergonomics* 29 (6), 451-459.



## THE RELATIONSHIP BETWEEN PHYSICAL FITNESS, PHYSICAL WORK INTENSITY, AND WORK ABILITY INDEX (WAI)

KIM Y.K.<sup>1</sup>, KANG D.M.<sup>1</sup>, YANG D.J.<sup>2</sup>, KIM Y.H.<sup>2</sup>

<sup>1</sup> Pusan National University, Yangsan Hospital, Yangsan, Korea - <sup>2</sup> Korean Occupational Health & Safety Agency, Incheon, Korea

### Aims:

Whether work influences physical fitness is controversial. There were no studies concerning on the relationship between physical fitness and work ability index (WAI). So we investigated the relationship between physical fitness, physical work intensity and WAI.

### Methods:

Physical fitness tests were conducted at Pusan branch of Korean occupational health & safety agency (KOSHA) in 2009. Physical fitness test items were maximal O<sub>2</sub> consumption, grasping power, sit-up, sit-and-reach, Sargent Jump height, and response time of stimuli. Number of subjects was 1,097 workers. All physical fitness tests were measured by Helmas III with structured protocol. The questionnaire included age, sex, smoke, alcohol, exercise, job contents, work ability index, and physical work intensity. Physical work intensity comprised 9 grades from “be seated with ease” to “keep working with heavy tool like pick man”. Statistical analysis is conducted for frequency test, t-test, and logistic regression. Statistical significance level was 0.05, and SAS (v9.1) was used.

### Results:

Maximal O<sub>2</sub> consumption, jump height, and response time in male blue-collar were higher than white-collar males, and jump height and response time higher in female blue-collar workers were higher than white-collar females ( $p < 0.01$ ). Physical work intensity in blue-collar workers was higher than white-collar. Higher physical work intensity corresponded with higher maximal O<sub>2</sub> consumption and grasping power, but the rest of physical fitness test was not correlated. WAI scores were not statistically significant between blue and white-collar workers and not related with physical fitness. Also physical work intensity was not related with WAI.

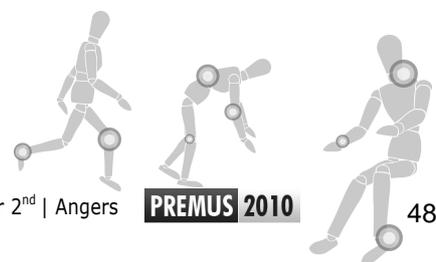
### Conclusion:

We found that higher physical work intensities affected on cardiopulmonary endurance and muscular strength. So work may be positive influence on some parts of physical fitness. And work ability index couldn't explain physical fitness.

**Keywords:** Economics, older workers, gender differences

### References:

- Gall, B., Parkhouse, W. Changes in physical capacity as a function of age in heavy manual work. *Ergon*. 2004;47:671-687.  
Lindberg, P., Josephson, M., Alfredsson, L. et al. Promoting excellent work ability and preventing poor work ability: the same determinants? Results from the Swedish HAKuL study. *Occup Environ Med*. 2006;63:113-120.  
Nygard, CH., Eskelinen, L., Suvanto, S. et al. Associations between functional capacity and work ability among elderly municipal employees. *Scand J Work Environ Health*. 1991;17:122-127.



## WOMEN'S PERCEPTION OF RISK FROM OCCUPATIONAL MUSCULOSKELETAL EXPOSURES

LANDRY L.

San Francisco State University, USA

### Aims:

This study examined a woman's demographics, health, occupational characteristics and the risk characteristics attributed to her occupational stressors as predictors of her perceptions about risk of injury to self and other women from occupational musculoskeletal exposures.

### Methods:

This cross-sectional study included a random sample of women who were employed in the 12 months prior to survey administration (n=123, 27% response rate). A telephone survey consisting of 154 items was administered in English or Spanish.

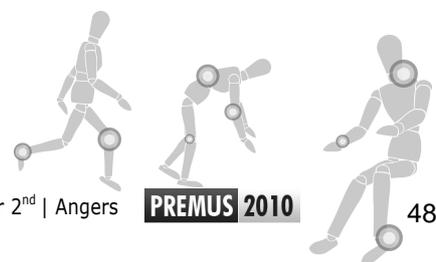
### Results:

For the perception of risk of injury to self, the final multiple regression equation explained approximately 66% of the variance with significant unique contributions identified for bodily pain, occupational exposure to repeated strenuous physical activity or repetitive hand motion, perceived seriousness and controllability of the risk, and perception of risk to other women. Similarly, for perception of risk of injury to other women the final multiple regression equation explained approximately 57% of the variance with significant unique contributions identified for household size, occupational exposure to repetitive hand motion, familiarity of the risk, and perception of risk of injury to self.

### Conclusion:

Exposure experiences and risk characteristics were found to increase women's perceptions of risk from occupational musculoskeletal exposures.

**Keywords:** Postures, physical exposure, psychosocial factors, personal risk factors for MSD



## GENDER IN EXPECTATIONS BEFORE VISITS TO PRIMARY CARE FOR NECK AND BACK PATIENTS

STENBERG G., FJELLMAN-WIKLUND A., AHLGREN C.

*Department of Community Medicine and Rehabilitation, Physiotherapy Umeå University, Umeå, Sweden.*

### **Aims:**

To explore if expectations on consultation and treatment for neck or low back pain in primary care are gendered.

### **Methods:**

In depth interviews on specific themes were conducted with 12 patients, 7 women and 5 men, (20-65 years), seeking care for neck- or low back pain before their first appointment with physiotherapist or general practitioner. The interviews were tape recorded and transcribed verbatim and analysed according to Grounded Theory.

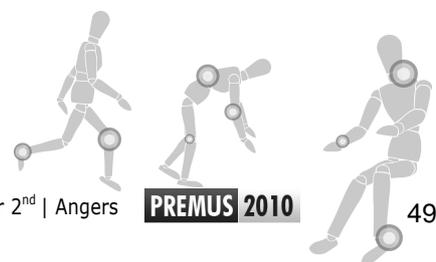
### **Results:**

The expectations expressed, formed four categories, “to be taken seriously”, to get explanations”, “to be invited to participate”, and “to be assessed in a context”. According to the patients’ way of expressing their expectations two ideal types were formed, “The Proud” and “The Ashamed”, which was strongly connected to sense of identity. Depending on ideal type, different meanings were given to the categories. The Ashamed type was afraid of not being taken seriously and included more women, while The Proud type, who trusted his/her own ability included more men. However, the types were not totally defined by sex. All interviewees had their own theories about the cause of the pain and hoped to get a professional explanation. The Proud expressed a clear cause while the Ashamed were more hesitant and blamed themselves for getting pain. The interviewees wanted to be active and participate in the treatment. Especially The Ashamed type was eager to state the willingness to do a lot by her/himself. To be assessed in a context was important for all interviewees as well as to be coached and to get a follow up.

### **Conclusion:**

Gender seems to affect the expectations and how patients view and express their problems. Health care professionals should consider this in the consultation.

**Keywords:** Gender differences, back, low back, neck



## GENDER DIFFERENCES IN SIZE AND STRUCTURE OF VARIABILITY

SVENDSEN J.H., MADELEINE P.

*Laboratory for Ergonomics and Work-related Disorders, Center for Sensory-Motor Interaction (SMI), Dept. of Health Science and Technology, Aalborg University, Aalborg, Denmark*

### Aims:

The primary goal of this study was to investigate gender differences in relation to force stability during a mono-directional contraction. For this purpose variability of the task-related and tangential forces was analyzed by means of linear (size of variability) and nonlinear (structure of variability) analysis during discrete and continuous isometric elbow flexions.

### Methods:

20 healthy subjects participated in this experiment with equal numbers of males and females. Isometric elbow flexion was recorded by a 3D force sensor in 3 different tasks: Short duration contractions in the range of 10 to 90% MVC with 10% MVC increment, a ramp contraction from 5 to 50% MVC and at last a sustained contraction until fatigue. Linear (standard deviation) and nonlinear (sample entropy) measures were calculated from the force signal in the elbow flexion direction, as well as the tangential directions, to assess size and structure of variability in the force signals.

### Results:

During short duration contractions, size of variability increased with contraction level while structure of variability followed an inverted U-shape function ( $p < .01$ ). Task-related force showed larger size of variability compared to the tangential forces, but for the structure of variability this pattern was opposite ( $p < .01$ ). From the endurance test, it was found that females had longer endurance time than males ( $p < .01$ ). Size of variability increased with contraction time ( $p < .01$ ), but structure of variability was unchanged. Like in the short duration contractions, task-related force was larger in size of variability compared to the tangential forces, but it was opposite for the structure of variability. Both size and structure of variability were consistently higher in males than females ( $p < .01$ ).

### Conclusion:

In general, size of variability increases with contraction level or fatigue, where the structure of variability is unchanged. These changes in variability argue for neuromuscular mechanisms aiming at preserving the structure of variability on the expense of more fluctuations. Gender differences were also present, not only by a strength difference, but also revealed by the complexity of contraction control. The gender differences points toward gender-dependent force control mechanisms that could contribute to the higher prevalence of musculoskeletal disorders among females.

**Keywords:** Biomechanics, postures, physical exposure, upper limb



## THE EFFECT OF COGNITION IMPROVEMENT PROGRAM ON WORK ABILITY

YANG D.J.<sup>1</sup>, YANG Y.A.<sup>2</sup>

<sup>1</sup> Korea Occupational Health & Safety Agency, Seoul, Korea - <sup>2</sup> Inje University, Kimhe, Korea,

### Aims:

Korea is very rapid aging society which results loss of productivity, increase of safety problem, and reduce of productive population by worsening of work ability. The aim is to study effects of cognition improvement program on work ability.

### Methods:

One hundred and ten workers among 3 companies in Seoul who wanted to participate in cognition improvement program were selected. Cognitive function at baseline was evaluated, and 3 step cognition improvement program was applied for intervention. Cognitive function test was re-evaluated to test effect of the intervention. MoCK-K was used to check cognitive function.

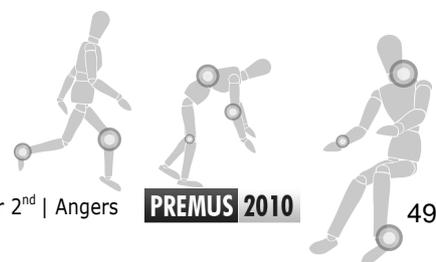
### Results:

Overall improvement of cognitive function was found with high improvement level among female workers with over 45 years old. Machine operator and assemblers who had lower cognitive function improvement has high work ability improvement.

### Conclusion:

Improved cognitive function after intervention was found. This result implies usefulness of cognitive improvement program to increase work ability. However this study has several limitations, and need more elaborated study including RCT.

**Keywords:** Economics, older workers, gender differences



## SURVEILLANCE AND PREVENTION POLICIES

### HEALTH AND SOCIOECONOMIC IMPACT STUDY OF EUROPEAN INITIATIVES ON THE PREVENTION OF WORK-RELATED MSDS IN EUROPE

BLATTER B.M.<sup>1,4</sup>, OPDEBEECK R.<sup>2</sup>, VAN DEN HEUVEL S.G.<sup>1</sup>, EECKELAERT L.E.<sup>2</sup>, TREUTLEIN D.<sup>1</sup>, KRAKER DE H.<sup>1</sup>, PAWLOWSKA Z.<sup>3</sup>, ROMAN-LIU D.<sup>3</sup>, HOLLANDER A.<sup>1</sup>

<sup>1</sup> TNO Quality of Life, Hoofddorp, The Netherlands – <sup>2</sup> Prevent, Brussels, Belgium – <sup>3</sup> CIOP, Warsaw, Poland – <sup>4</sup> Body@Work, Research Center on Physical Activity, Work and Health TNO-VU/VUmc, The Netherlands

#### Aims:

Work-related MSDs are covered by various Directives, some addressing specific risks such as working with computers or the manual handling of loads, and some addressing general topics. Not all MSD risk factors are covered by the EU Directives. Therefore, a new regulatory initiative was considered by the EU.

The aim of the present study was to estimate the health impact and socioeconomic impact of potential European initiatives to prevent WRMSDs, leading to recommendations on the EU regulatory or non-regulatory policy option that is the most promising approach.

#### Methods:

An impact assessment was conducted according to the impact assessment guidelines from the EU. Six policy options were formulated: 1) no policy change, 2) non-binding initiatives, 3) technical update of MSD-legislation, 4) technical update of MSD-legislation and non-binding initiatives, 5) simplifying MSD-legislation taking account of all risk factors, 6) simplifying MSD-legislation taking account of all risk factors and non-binding initiatives.

A literature study was carried out on the effectiveness of MSD prevention strategies at national and sector level and on prevention measures at company level. Also, an expert survey was conducted among 78 experts from 23 European countries. The experts were asked to review the impact of national initiatives and to estimate the specific impact of implementing EU policy options taking the situations in their own countries into account. In addition, a more detailed round of consultation was organised in nine countries.

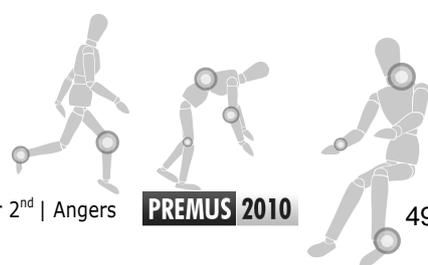
#### Results:

Overall, option six (simplification of the legislation in combination with undertaking/enforcing non-binding activities) was preferred by the experts who filled out the expert survey and who were present at the country consultations. From the qualitative and semi-quantitative impact assessments based on literature and expert judgement, policy option six also seemed to be the option with the highest impact on indicators at national, sector and company level. We deduced from those results that this option in the end probably leads to the highest impact at individual level, such as the decrease of WRMSDs, because individual level indicators are all dependent on the actions taken at higher levels.

#### Conclusion:

Overall, option six was the most promising approach. However, there was no consensus on the results: there were differences between scientific researchers, employers' organizations and employees' organizations. There was also discussion in the country consultations on the exact interpretation of the issue of threshold levels in option six.

**Keywords:** Postures, physical exposure, Computer work, Public policy.



## WMSD SURVEILLANCE USING WORKERS COMPENSATION (WC) DATA

SILVERSTEIN B., ADAMS D.

SHARP- Washington State Dept Labor & Industries, USA

### Aims:

Health surveillance provides WMSD information for action. Washington State WMSD WC claims incidence rates are used to assess need for and effects of prevention activities.

### Methods:

We examined Washington WC claims for general and selected upper extremity disorders 1999-2007. Payroll hours were used to calculate claims incidence rates per 10,000 full-time equivalent employees (FTEs). We created a prevention index (PI) to rank industries by averaging the ranks of their number of claims and their claims incidence rate.

### Results:

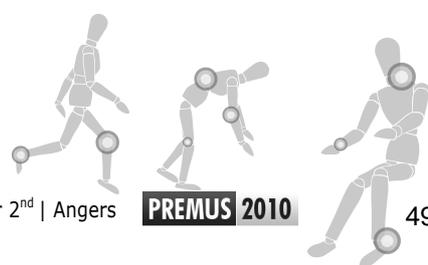
Between 1999-2007, there were 117,303 State Fund accepted upper extremity WMSD WC claims (10% of all claims), with an average claims incidence rate (CIR) of 61.6 and severity rate of 7,947 days per 10,000 FTEs and \$1.9 billion in direct costs. The CIR was 14.0/10,000 FTEs for rotator cuff syndrome (RCS), 7.4 for epicondylitis, 12.7 for hand/wrist tendinitis, 16.0 for CTS with respective severity rates of 3171, 864, 1546 and 2913 lost work days per 10,000 FTE. Industry sector PI order was Construction, Manufacturing, Transportation & Utilities, Trade, Finance, Health Care, Mining and Agriculture.

Based on PI by WC State Fund risk class, the top 7 industries for upper extremity WMSDs were state patient/health care personnel, wallboard installation, non-wood frame building construction, trucking, roofing work, wood frame building construction and temporary help machine operators. These were similar for rotator cuff and epicondylitis. However, for tendinitis and CTS, barber and beauty shops, supermarkets, meat, fish & poultry wholesalers and plastic goods manufacturing, logging and metal goods manufacturing were added.

### Conclusion:

The PI suggests focusing on manual handling work for RCS and epicondylitis but more hand intensive work for CTS and tendinitis. The PI is a useful way to prioritize prevention work and establish policies for action.

**Keywords:** Surveillance, Public policy, Upper limb



## STRATEGIES FOR MSD PREVENTION – A NEW MODEL PROPOSED BY A BELGIAN TASK FORCE

SOMVILLE P.R., MAIRIAUX P.

CBMT, Occupational Health Services and Department of Public Health, University of Liège, Liège, Belgium

### Aims:

Recent literature reviews suggest that training in handling or ergonomics interventions have a weak impact, if any, on the incidence of musculoskeletal diseases, particularly for early prevention of back problems. In practice, a large variety of training programs and interventions are proposed to enterprises by occupational health services (OHS) without any standardization nor evaluation of those programs. In view of both the scientific evidence and the enterprises needs, the Belgian Public Federal Service of Employment and Labour (PFSEL) decided to set up a task force aiming at the definition of “good practice guidelines”. These guidelines were meant to establish a bridge between evidence-based statements and prevention practitioners, and to raise the quality of the interventions at the workplace.

### Methods:

To achieve this objective, the PFSEL invited as members of the task force not only recognised experts but also experienced trainers, ergonomists, and specialists in rehabilitation medicine. Three round tables took place in 2007 and 2008, at 3 months interval, in order to reach a consensus on the present scientific evidence, and the nature and content of the interventions that should be part of early prevention strategies for both back pain and upper limb disorders.

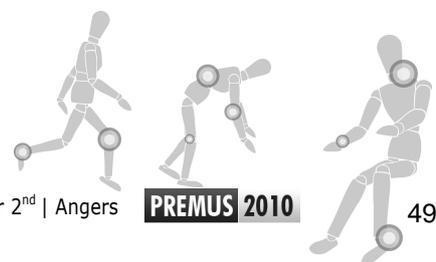
### Results:

The proposed practice guidelines involve the following steps: (a) an ergonomic analysis to identify the workers at risk and the intervention needs, (b) the definition of homogeneous groups in terms of exposure (no matter past pain history) as target for the intervention and the selection in each group of a “referent” worker (not to be confused with a coach), (c) the preparation of the intervention by the ergonomist with the referent worker help, (d) an intervention module of 8h duration divided in 3 phases (4+2+2) over a one-month period and combining training and participatory ergonomics for groups of 6 to 12 workers and their supervisor, (e) follow-up performed by the workers supervisor and the referent worker and involving “refresher sessions” by the ergonomist. This intervention model is thus multidimensional, associating training in working techniques and stimulating ergonomic changes at the initiative of the workers and their supervisor.

### Conclusion:

Based on this intervention model, the good practice guidelines will soon be published by the Belgian government and circulated among companies, trade unions, OHS and ergonomists. Feasibility in applying such guidelines will have to be tested as well as the actual impact on MSDs.

**Keywords:** Early prevention, Intervention methods.



## EPIDEMIOLOGY OF UPPER LIMB MUSCULOSKELETAL DISORDERS AND WORK DISABILITY IN 2.300.980 INSURANTS OF THE STATUTORY HEALTH INSURANCES IN GERMANY

OCHSMANN E.B.<sup>1</sup>, ESCOBAR L.C.<sup>2</sup>, KRAUS T.<sup>1</sup>, LETZEL S.<sup>2</sup>, MUENSTER E.<sup>2</sup>

<sup>1</sup> Institute of Occupational and Social Medicine, Medical Faculty, RWTH Aachen University, Germany - <sup>2</sup> Institute of Occupational, Social and Environmental Medicine, University Medical Center of the Johannes Gutenberg University Mainz, Germany

### Aims:

Upper limb disorders (ULD) play an important part within the field of musculoskeletal disorders. Until now, little is known about the prevalence rates of diagnosed ULD and the according workdays lost in the German general population, this study aimed at closing this gap.

### Methods:

We conducted a secondary data analysis of a large population based data set consisting of 2,300,980 persons (3% random sample of all insurants of statutory health insurances in Germany in 2002) with regard to the ICD-10 diagnosis G56 (mononeuropathies of the upper limb), M65 (synovitis and tenosynovitis), M75 (shoulder disorders) and M77 (other enthesopathies). Prevalence rates and workdays lost because of these diagnoses were analysed for the subgroup of 15-64 year old persons and, wherever possible, extrapolated to all insurants (about 72 Million persons).

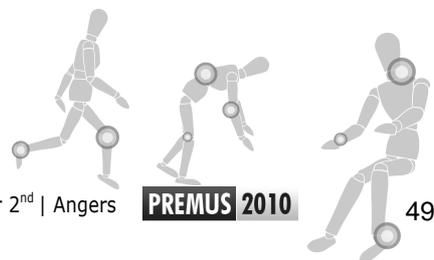
### Results:

Altogether 1.7% of the study population were diagnosed with mononeuropathies (G56), 1.8% with (teno)synovitis (M65), 3.6% were diagnosed with M75 (shoulder lesions) and 4.3% with other enthesopathies (M77). Of all patients with G56, 11.4% did not go to work because of this diagnosis and stayed home for an average 41 days, 26.4% of the persons diagnosed with M65 stayed away from work for, on average, 20 days, 13.2% of the persons diagnosed with M75 stayed away from work for 36 days, and 14.3% of the insurants with M77 stayed away from work for 29 days. With 8.5 million workdays lost, shoulder disorders accounted for the highest number of workdays lost because of ULD in Germany. Within all diagnoses, we found age and gender-effects.

### Conclusion:

ULD are a public health problem with a major influence on the workplace. But the here depicted differences in ULD with regard to prevalence and duration, might give reason to prioritize preventive measures when tackling musculoskeletal diseases at the workplace. With regard to workdays lost, shoulder lesions seem to be most important.

**Keywords:** Surveillance, Epidemiology, Upper limb



## ERGONOMIC FACTORS OF TRAUMATIC LOW BACK PAIN APPROVED IN 2006-2008 WORKERS' COMPENSATION CLAIMS

PARK J.K., LEE H.K., JANG S.H.

*Korea Occupational Safety and Health Agency, Incheon, Korea.*

### Aims:

Musculoskeletal disorder (MSD) cases accounted for 68%, 74%, 77%, respectively, in non-fatal occupational illness cases approved in Korean workers' compensation claims for years of 2006, 2007 and 2008 (Park et al., 2008 and 2009). Low back pain (LBP) cases composed 78% of all MSD cases in 2008. In order to examine features of traumatic LBP ergonomic factors, it was necessary to investigate how much each of the factors was associated with occurrence of traumatic LBP in 2006-2008 workers' compensation claims dataset.

### Methods:

A pilot study was performed to look at what factor features existed in 955 sample cases selected randomly from the dataset. A 10-question checklist, which consisted of items focused on occurrence or causes of traumatic LBP, was used for coding. Each of 10 questions addressed an ergonomic factor (e.g., task type or risk factor), and then 10 questions were answered for a case. Exposure profiles were additionally examined for demographic and organizational factors as well. Proportion of distribution was obtained for each of questions and Chi-square test was done.

### Results:

A total of 12,782 cases were finally determined in data analysis. Distribution proportions varied for ergonomic factors across all cases. In risk factor, among factors, the highest proportion was 62.7% for 'forceful exertion,' followed by 10.0% for 'contact stress,' 2.2% for 'awkward posture,' 1.6% for 'repetition,' 0.2% for 'vibration.' Combined factors with forceful exertion accounted for at least 13.4% while others accounted for 9.9% in risk factor. The highest proportion in task type was 35.3% for 'lifting,' followed by 19.4% for 'transfer,' 4.9% for 'lowering,' 2.9% for 'pull,' 1.8% for 'push' and 1.5% for 'holding.' Combined factors with lifting accounted for at least 7.8% while others accounted for 26.4% in task type. These results were very significant. Further findings were extensively discussed.

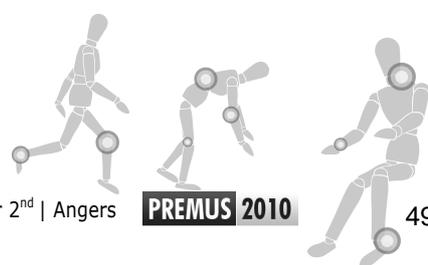
### Conclusion:

It was shown the proportions for ergonomic factors were reasonably distributed in the 2006-2008 Korean workers' compensation claims dataset. For risk factor, 'forceful exertion' proportion was overall 76.1% to associate with occurrence of traumatic LBP while 'lifting' was overall 43.1% to do for work type. The study results suggest that forceful exertion among risk factor items should be first addressed, and that lifting among task type items should be also primarily selected in controlling traumatic LBP at work.

**Keywords:** Postures, Physical exposure, Epidemiology, Back, Low back

### References:

- Park, J-K., D-S. Kim, K-B. Seo. Musculoskeletal disorder symptom features and control strategies in hospital workers, Journal of the Ergonomics Society of Korea. 2008;27(3):81-92 (in Korean)  
Park, J-K, K-S Kim, J-H Kim, J-Y Kim. Effects of factors on low back pain symptoms in Korean hospital workers. Proceedings of the 17th Triennial Congress of International Ergonomics Association (CD). 2009;Beijing, China



## UNDERREPORTING OF NON-TRAUMATIC WORK-RELATED MUSCULOSKELETAL DISORDER WORK ABSENCES TO WORKERS' COMPENSATION: RESULTS OF A 2007-2008 POPULATION SURVEY

STOCK S.R.<sup>1</sup>, FUNES A.<sup>2</sup>, DELISLE A.<sup>3</sup>, TURCOT A.<sup>4</sup>, MESSING K.<sup>5</sup>

<sup>1</sup> Quebec Institute of Public Health (Institut national de santé publique du Québec) and School of Public Health, University of Montreal, Montreal, Québec, Canada [susan.stock@inspq.qc.ca](mailto:susan.stock@inspq.qc.ca) - <sup>2</sup> Quebec Institute of Public Health (Institut national de santé publique du Québec), Montréal, Canada - <sup>3</sup> University of Sherbrooke, Sherbrooke, Canada - <sup>4</sup> Quebec Institute of Public Health (Institut national de santé publique du Québec), Québec, Canada - <sup>5</sup> University of Quebec in Montreal, Montreal, Canada

### Aims:

The objective of this study was to estimate the proportion of non-management salaried employees with work absences in the previous 12 months due to non-traumatic musculoskeletal symptoms attributed to work who filed a workers' compensation claim and the proportion who did not receive any salary replacement during their work absence.

### Methods:

A telephone survey of a population-based representative sample of 5000 Quebec workers was conducted in 2007-2008 (response rate 62%). The presence and frequency of significant musculoskeletal symptoms in the previous 12 months, interfering with activities, of the neck, upper extremities, back and lower extremities were measured. MSD of traumatic origin were identified and excluded from the case definition. Respondents were also asked if symptoms were perceived to be partially or entirely work-related, about work absence due to these symptoms and its duration, source of income during work absence, and whether a workers' compensation claim had been filed.

### Results:

7.3% of all respondents reported a work-absence of at least 1 day due to non-traumatic musculoskeletal symptoms in at least one body region attributed to work (6.5% men, 8.3% women). Among non-management salaried employees with work-absences due to non-traumatic musculoskeletal symptoms attributed to work (partially or entirely) in the previous year, 22.7% did not receive any income replacement during their work absence and only 13.6% filed a workers' compensation claim. Among those whose MSD symptoms were perceived as entirely work-related, 19.6% filed a WCB claim. This proportion rose to 36.1% among those who perceived their non-traumatic MSD symptoms as entirely work-related and were off work for more than 2 weeks (vs. 12.6% among those who were absent less than 2 weeks). Data on reasons for not filing WCB claims will also be presented.

### Conclusion:

More than 80% of Quebec non-management salaried workers with work absences due to MSD symptoms perceived as entirely work-related did NOT file WCB claims. In 2007-2008 underreporting of non-traumatic work-related MSD to WCB is extremely high. This limits the usefulness of compensation data for surveillance purposes to identify groups at highest risk requiring prevention. It also suggests there may be very high proportions of workers with MSD disorders who may have limited access to rehabilitation services and timely return to work through offers of modified work. Increasingly throughout Canada access to many rehabilitation services are only available through private health services and may not be accessible to those in lower socioeconomic groups who may be most in need of them.

**Keywords:** Surveillance, Epidemiology, Public policy



## A MORE OBJECTIVE EVALUATION OF THE REPETITIVENESS IN THE COMPENSATION OF MUSCULOSKELETAL DISORDERS: THE CASE OF TUNISIA

AMRI C., BOUZGAROU L., MAHFOUDHI A., ADNENE HENCHI M., CHAARI N., AKROUT M., KHALFALLAH T.

*Department of occupational health and safety, Monastir, Tunisia*

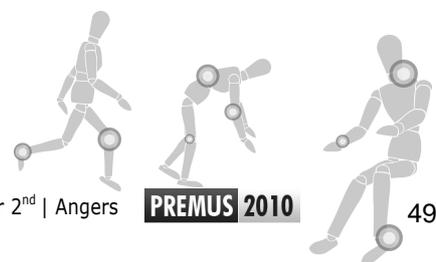
During these last decades, the incidence of occupational declared upper-limb musculoskeletal disorders (ULMSD) did not stop increasing with an alarming evolution of their human and financial costs. These pathologies, joining a probabilistic model, are characterized by a causality shared between occupational and non occupational risk factors with a more controversial participation of each one of them. In addition to the organizational and psychosocial factors, the main biomechanical constraints (postures, repetitiveness, strength level developed and static work) were the predominant influences according to the articular areas. Among these factors, the repetitiveness is a notion which remains ambiguous and vaguely defined in numerous studies, guides for physicians, as well as in compensation systems. This notion leads to subjective interpretations, and significant different appreciations, particularly for indemnity procedure.

In Tunisia, aiming to limit this subjectivity, to emphasize this disorder identification and to establish more effective prevention strategies, an expert's consensus with a revision of the table number 82 was established.

This consensus proposed a more objective tool for repetitiveness evaluation by considering the gestural variability as an indicator of the repeated movements, one of major biomechanical factors of the ULMSD. Therefore, the number of the movements per minute was considered and a minimum duration of exposure in the repetitive work was fixed.

The elaboration of such tool will insure for the medical practitioners an early screening of the potential TMS risk situations, and so assess a more efficient prevention intervention; as well as a more equitable satisfaction of various social partners.

**Keywords:** Work organization, exposure measurement methods, carpal tunnel syndrome



## CONDITIONS FOR IMPLEMENTING A SUSTAINABLE MSD PREVENTION IN THE WORKPLACES, A STUDY CASES OF 30 FRENCH COMPANIES

ESCRIVA E.<sup>1</sup>, COUTAREL F.<sup>2</sup>, CAROLY S.<sup>3</sup>, DANIELLOU F.<sup>4</sup>, ROQUELAURE Y.<sup>5</sup>, SCHWEITZER J.M.<sup>6</sup>

<sup>1</sup> National Agency for the Improvement of working conditions (ANACT), Lyon, France – <sup>2</sup> Department of Sciences and Techniques of Physical Activities and Sports (UFR STAPS), Blaise Pascal University, Clermont-Ferrand, France – <sup>3</sup> Laboratory PACTE, University, Grenoble, France – <sup>4</sup> Department of Ergonomics, Cognitique Institute, Victor Segalen University, Bordeaux, France – <sup>5</sup> Laboratory of Ergonomics and Epidemiology in Occupational Health (LEEST), Faculty of Medicine, Angers, France – <sup>6</sup> Regional Association of Lorraine (ARACT Lorraine), Metz, France

### Aims:

The number of MSDs increased steadily since the 1990's. Numerous interventions in workplaces, studies and symposia brought together researchers and professionals. Their intervention strategy became clearer. Companies succeed in reducing complaints and improving production, but occupational diseases and productive disorders return after thereabouts two years. This raises questions about conditions of a sustainable MSD prevention [1].

Three research teams and ANACT network conducted between 2004 and 2007 an intervention research, supported by the French Ministry in charge of labour, concerning obstacles and driving forces to implement a sustainable prevention in companies. This study provided a better understanding of practices and proposes recommendations applied to the system of prevention [2].

### Methods:

First, consultants led retrospective analysis in thirty industrial and service companies, on the basis of a common reference. Secondly, they accompanied eighteen volunteers in their MSD project. Their intervention strategy was recounted in a logbook and by interview. The overall analysis is based on comparison of monographs drafted on these two steps.

### Results:

Companies are adjusting occasional and local over time, when workers suffer from MSD, without capitalize on their actions. A more proactive, collective and comprehensive approach is still rare. This trend is related to corporate governance, project management, production organization, HRM and workers' knowledge recognition.

- A stable leadership is an asset unlike high turnover or limited autonomy
- A collective dynamics based on common references and outside opening (club, external counselling) allow a steady project. Weak internal resources, a non-shared and restrictive MSD pattern and a low involvement of staff representative bodies undermine it
- The prevention efforts are most effective by improving organization, but most companies are facing dislocated organizations constantly producing MSD
- Very few companies take into account occupational health indicators and workers' complaints, which reveal hardness and malfunctions. This requires tools for data collection and good relations between Human Resources and occupational health. Denying workers' difficulties is an aggravating factor of MSD. Workers need manoeuvring margins to develop a professional act, namely adapting their gestures to contexts and events production. Discuss ways and means is a promising prevention resource.

### Conclusion:

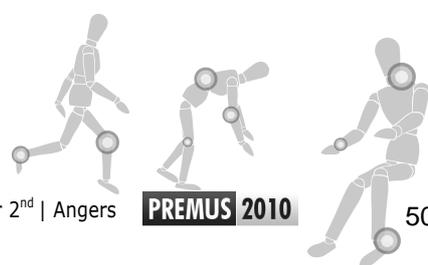
This study offers recommendations on accompanying forms and necessary conditions to sustain companies' involvement over time: Extend managers' awareness through training on TMS and prevention project management; Support a mode of corporate governance in order to influence the work systems design; Strengthen prospective HRM, training and transmission of professional gesture...

**Keywords:** Work organization, Intervention studies, Public policy.

### References:

[1] DOUILLET P., SCHWEITZER J.M. - « Les conditions d'une prévention durable des TMS : actes du séminaire des 7 et 8 juillet 2004 », EDITIONS DE L'ANACT, 05/2005, 123 pages

[2] CAROLY S., COUTAREL F., ESCRIVA E., ROQUELAURE Y., SCHWEITZER J.M., DANIELLOU F. - « La prévention durable des TMS. Quels freins? Quels leviers d'action? Rapport DGT recherche-action 2004-2007 », EDITIONS DE L'ANACT, 01/2008, 180 pages



## EPIDEMIOLOGICAL SURVEILLANCE OF UPPER LIMB MUSCULOSKELETAL DISORDERS (ULMSDs) IN OCCUPATIONAL SETTING IN A WEST REGION OF ALGERIA.

GHOMARI O., BEGHADLI B., TALEB M., KANDOUCI A.B., DESCATHA A., FANELLO S., ROQUELAURE Y.

*Laboratoire de recherche environnement et santé université de Sidi bel abbés (Algérie)*

### Aims:

This cross-sectional and multicenter survey aims to estimate the prevalence rate of ULMSDs and exposure to risk factors in industrial companies. Occupational physicians, organized in an epidemiological sentinel surveillance of upper limb musculoskeletal disorders network have participated in this survey.

### Methods:

In 2008, clinical data was collected using a questionnaire such as "Nordic" for morbidity symptoms and clinical examination, according to the standardized diagnostic approach of the European SALTSA consensus. The ULMSDs were classified into three degrees of severity after validation of a diagnostic by a "decision tree". Risk factors of ULMSDs were collected by a questionnaire including the biomechanical, psychosocial and organizational factors. The exposure scores were calculated for each anatomical area of upper limb by summation of risk factors revealed by the consensus.

### Results:

933 employees in eight industrial companies were included at random. Almost one in two workers has suffered in the past 12 months and one in four workers in the past 7 days, from non-specific upper limb musculoskeletal symptoms. The prevalence rate of diagnosed ULMSDs was high: 12% of workers sustained at least one form proven form of unilateral or bilateral ULMSDs, 6.3% a rotator cuff syndrome, 1.8% had lateral tennis elbow, 2.8% a carpal tunnel syndrome. The prevalence rate of ULMSDs increased with age and varied widely across companies and occupations. One in two workers was exposed to, at least, two risk factors from the upper limb, which is the warning threshold of SALTSA consensus.

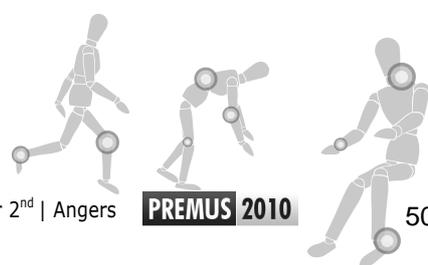
### Conclusion:

The use of the SALTSA protocol for the first time in Algerian companies revealed the importance of the prevalence rate of ULMSDs and exposure to risk factors. These results show the need to structure the occupational physicians in an epidemiological sentinel surveillance network so as to develop a prevention program in most sectors and reduce the prevalence of ULMSDs.

**Keywords:** Surveillance, Epidemiology, Upper limb

### Reference:

Kuorinka I, Jonsson B, Kilbom A, Vinsterberg H, Biering-Sorensen F, Andersson G, Jorgensen K. Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics* 1987; 8(3): 233-37.



## AN ASSESSMENT METHODOLOGY FOR ERGONOMIC CHAIR QUALITY AND COMPETENCY IN THE WORKPLACE

HELLER-ONO A.R.

County of Monterey, Canada

### Aims:

This abstract aims to introduce an assessment methodology to evaluate the quality and competency of an office ergonomic chair by using a relative value score to determine whether it should remain in use or be removed from circulation. The methodology is based on an objective and measurable rating scale to better determine which chairs should be replaced as a result of wear and tear over time. The methodology allows a more "scientific and objective" decision to be made, rather than rely on an employee's subjective opinion of the chair thereby eliminating bias in the chair replacement process.

### Methods:

The assessment methodology focuses on a 3- point scoring system to determine if an ergonomic chair should remain in the workplace or be removed for repair or replacement. The five categories chosen to determine ergonomic chair competency includes the age of the chair, cushion/fabric quality, the operational mechanics, end-user comfort and overall quality of the chair. A total value score is then assessed to determine whether the chair should be replaced or not. Each chair was individually tested and rated by the Ergonomics Manager. End-user feedback was obtained for the comfort rating.

### Results:

In an analysis of 59 office ergonomic chairs in a busy government department using the assessment methodology, 71% or 42 chairs were determined as incompetent for continued use and 29% or 17 chairs were determined as fit to remain in the workplace. Furthermore, the assessment identified the types of chairs in use by the department, when a majority of chairs were purchased and whether they were still within warranty if repairs were needed.

### Conclusion:

Using the assessment methodology described to assess the quality and competency of an office ergonomic chair provides objective and valuable insight for an organization as to whether the chair can remain in operation for safe and productive work. The methodology allows the organization to prioritize which chairs should be replaced based on the age of the chair, fabric/cushion quality, operational mechanics, end user comfort and overall value. This, in turn, allows them to anticipate the budget necessary to purchase and replace the selected chairs over time. Replacing ergonomic chairs that are worn out or broken is an important part of an ergonomics program to prevent and manage seated work injuries more effectively.

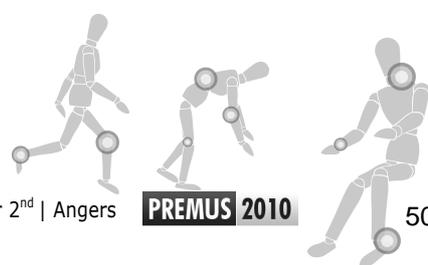
**Keywords:** Computer work, Early prevention, Economics

### References:

BIFMA G1-2002 Ergonomics Guidelines for VDT Furniture Used in Office Work Spaces

ANSI/HFES 100-2007 Human Factors Engineering of Computer Workstations

Lueder, Rani,



## STANDARD TO PREVENTION OF MUSCULOSKELETAL DISORDERS AMONG CALL CENTER OPERATORS IN BRAZIL.

PERES C.C., ROCHA L.E., BARREIRA T.H.C., MARINHO-SILVA A., MATSMOTO R., CAVALCANTE E.

Ministry of Labour - Dep. Med. Legal, Ética Médica e Med. Social e do Trabalho, Lim-40; University of São Paulo, Brazil

### Aims:

To show the Brazilian regulations for the prevention of musculoskeletal disorders and working conditions of call center operators in Brazil.

### Methods:

Call center involves around 900.000 workers in Brazil. These workers complained of Work Related Musculoskeletal Disorders and various psychic, vocal and auditive disturbances. Ministry of Labour and Employment (MTE) agencies in different states were asked to intervene by Unions representing telemarketing operators and developed inspections at the workplaces and organized events with the participation of Universities, Unions, employers' organizations and professionals in the area during the period of (5) five years, from 2000 to 2005. In 2006 was published a Portaria nº153 for public consultation about a guideline of call center working conditions. In 2007 a Tripartite Multiprofessional Working Group was organized to undertake collective negotiation that resulted in an attachment for the Regulation nº 17("Ergonomics"). This article describes this Regulation (Portaria nº9, de 30/03/2007).

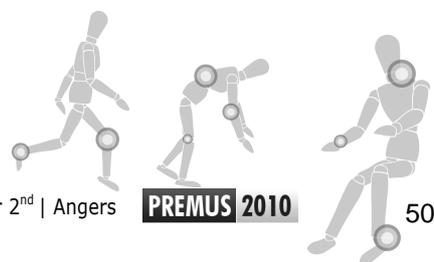
### Results:

The standard covers: furniture of workstation; equipments; work environment (noise, lighting, thermal comfort, air quality); work organization (maximum of six hours a day of working hours with two continuous rest break of ten minutes already included in the working hours without damaging the remuneration and the interval required to rest and food which is the twenty minutes , scripts prescriptions, professional evaluation, monitoring production, adequate number of workers); ambiguity and role conflict; discourages excessive electronic monitoring activity by the employer; workers training about risk factors, health effects and prevention in call center work; hygiene conditions; occupational health preventive programs and handicaps people.

### Conclusion:

This initiative gave the Ministry of Labor and Employment an important legislative tool to the prevention of musculoskeletal disorders and other occupational injuries in workers of the important and large sector of telemarketing, with the participation of enterprises' and workers' representatives. It is important to construct guidelines with participation of enterprises', workers' representatives and government to prevent musculoskeletal disorders.

**Keywords:** Psychosocial factors, work organization, public policy



## ERGONOMIC RISKS AND MUSCULOSKELETAL DISORDERS PREVENTION

IORDACHE R., GRIGORIU I., SERACIN M.

*National Research and Development Institute for Labour Protection, Ergonomics Department, Bucharest, Romania*

### **Aims:**

The present work has envisaged the identification of the work places/activities that involve ergonomic risks and musculoskeletal disorders (MSDs), as well as the elaboration of several instruments to identify and assess the ergonomic risks and their effects and give a support to the organizations in their attempt to prevent the occupational risks.

### **Methods:**

An inquiry has been drawn up, based on a questionnaire which was sent to companies / occupational health and safety departments so that a national survey could follow. Moreover, the effects on health and safety of such risks were taken into account, namely the work accidents and MSDs, in order to develop a complete picture of the present state in the study and awareness of the researched issues. The work accidents and the MSDs occurred in relation with ergonomic risks and reported in the last 5 years were also taken into account, based on statistical national reports analysis. A number of instruments to identify and assess ergonomics risks and their effects was developed and validated.

### **Results:**

A large number of work related MSDs was found, but the occupational MSDs were very few in number, rated on the 7th or 8th place in the etiological structure of occupational morbidity. Only 32.40% of Romanian companies recognized presence of ergonomic risks. It should be also noticed a low reporting of the work accidents related to the ergonomic risks as consequence of ignoring their implications in the safety at work. A practical guide containing instruments and prevention measures of effects of ergonomics risks was been drawn up.

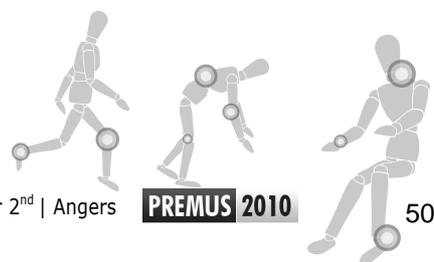
### **Conclusion:**

Action is needed to consolidate the culture of risk prevention, mainly the ergonomic and psychosocial risks in direct relation with the present situation in the world of work.

**Keywords:** Psychosocial factors, Work organization, Personal risk factors for MSD

### **References:**

Legea securitatii si sanatatii in munca, nr. 319/2006  
Hotararea de guvern nr. 355/2007 privind supravegherea sanatatii lucraorilor  
Niculescu T. (2002), Occupational Medecine, MedMun Printing House



**LOW BACK PAIN AND STRATIFIED MANAGEMENT: A NECESSITY**

PETIT LE MANAC'H A., ROQUELAURE Y., HA C., RICHARD I.

LEEST EA 4336, University of Angers, France

**Aims:**

In industrial countries absenteeism and disability due to low back pain reach a peak between the ages of 30 and 50 years and thus affect a population reaching the age of career advancement.

**Methods:**

The number of low back pain employees in the Pays de la Loire region is assessed according to census data and by the epidemiological surveillance network for musculoskeletal disorders.

**Results:**

The number of employees with low back pain is very high, with more than 268,000 employees having backache during the preceding seven days and more than half a million with backache during the twelve months preceding the survey. As ten percent of people with non-specific low back pain risk having chronic low back pain in due course, this would involve 57,000 employees. On the basis of 250 places a year in all the rehabilitation centres in the region, this amounts to treating 0.5% of patients with low back pain.

Table 1. Low back pain in Pays de la Loire's employees

	Pain during 12 last months	Pain during 7 last days
Women	244,253	118,503
Men	316,552	150,059
Total	560,805	268,561

**Conclusion:**

Although they prove effective in the short and medium term, functional rehabilitation programmes are costly and not appropriate for such large groups of patients.

It is therefore necessary to:

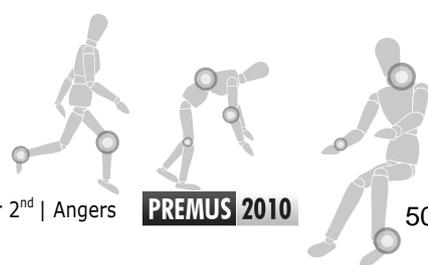
- Develop optimal treatments that specifically target the prognostic profiles of patients, combined with appropriate training for primary care physiotherapists. Early management of persistent non-specific low back pain (beyond six weeks) would prevent transition to chronic back pain.
- Identify patients with poor prognosis that require targeting and more complex treatment with bio-psycho-social management. This type of management must be reserved for patients with severe handicap or poor prognosis.

In view of the fact that the prevalence of chronic low back pain has increased 2.6-fold in the last fifteen years, and that resort to treatment increases for the same level of incapacity, it is urgent to change our management of such patients.

**Keywords:** Disability prevention, public policy, back, low back

**References:**

Hill JC. The way forward in managing back pain-targeting treatment. *Ann Rheum Dis* 2009;68 (suppl3):15 [SP0044].  
NICE recommends early intensive management of persistent low back pain. *BMJ*, 2009;338:1289.



## **DETERMINING WORK-RELATEDNESS OF MUSCULOSKELETAL INJURIES- PLANTAR FASCIITIS AS A CASE EXAMPLE.**

WONG R.C.K., NAQVI S.

*Occupational Health Clinics for Ontario Workers*

### **Aims:**

Legal and health professionals address causality using different criteria. We aim to describe legal and health criteria in determining causality in work-relatedness, the scientific basis of plantar fasciitis and how Workers Compensation tribunals decide on plantar fasciitis and work-relatedness.

### **Methods:**

Legal criteria is based upon decisions in case laws. Summary reports from Commissions are used to describe the criteria. Scientific criteria is based upon published literature especially in the field of epidemiology on causality. The scientific basis of plantar fasciitis is based upon a search of databases such as Pubmed, Embase up to December 31, 2009.

### **Results:**

Legal criteria may be examined in terms of (1) Causation test of significant contribution that must be influential or important to the development of the disease that may have multi-causes. (2) Standard of proof depends on the balance of probabilities based upon the same standard of proof used in civil negligence cases.(3) Burden of proof implies that the decision-maker is responsible for collecting the relevant information and ensures that the necessary information is available to make an informed decision in the claim. Neither the worker nor the employer has the burden of proving their case.(4) Benefit of doubt is decided when the evidence for or against an issue is approximately equal in weight, the issue is decided in favour of the person claiming benefits. The scientific criteria depends on the systematic collection of information and applying criteria such as Bradford Hill's conditions to the information. The criteria also depends on pathophysiology and biomechanics of the condition. The physiological basis of plantar fasciitis is from degenerative causes from micro or macro trauma from work or recreation, metabolic (such as gout), autoimmune, foot structures and mechanical loading such as from obesity. Among letter carriers, 70% of letter carriers plantar fasciitis are recognized by Compensation Tribunals in British Columbia as work-related and 30 percent in Ontario.

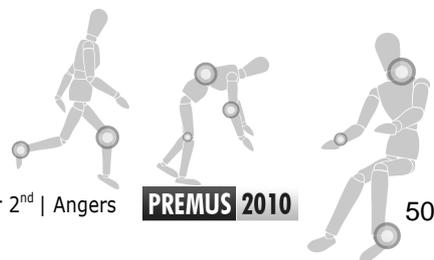
### **Conclusion:**

Legal and scientific criteria are fairly stable although they may change according to changes in case laws and scientific literature respectively. The scientific basis of plantar fasciitis changes regularly. Tribunal members usually have a legal background rather than a health background and how they interpret scientific literature and apply criteria will determine their final decision. There is a great amount of disparity on the understanding of health literature by Tribunal members. We need adequate knowledge transfer to facilitate fair decisions.

**Keywords:** Mechanism of pain and tissue injury, Public policy, Lower limb

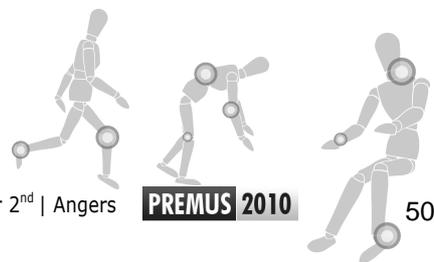
### **References:**

- B. Smith, "Final report of the chair of the Occupational Disease Advisory." <http://www.wsib.on.ca/wsib/wsibsite.nsf/Public/ChairsFinalReport>
- Hill AB. The environment and disease: association or causation? *Proc R Soc Med.* 1965;58:295-300.
- Greenland S. Causality theory for policy uses of epidemiologic measures. In: Murray CJL, Salomon JA, Mathers CD, Lopez AD, editor. *Summary Measures of Population Health.* Cambridge Harvard University Press/World Health Organization; 2002:291-302.

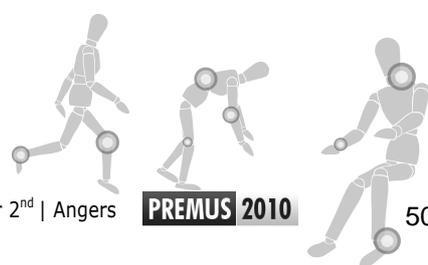


# INDEX OF AUTHORS

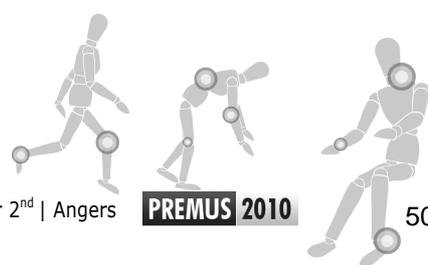
## *ERRATUM*



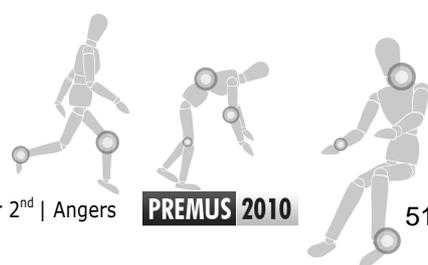
- AAS R.W., 416  
 ABDOLI-E M., 234  
 ABMA F.I., 68  
 ADALARASU K., 180  
 ADAMS D., 148, 505  
 ADNENE HENCHI M., 324, 510  
 AGNEW M.J., 234  
 AHLGREN C., 497, 501  
 AHLSTRAND C., 492  
 AHMED M., 215, 340  
 AJEESH P.S., 275, 453  
 ÅKESSON I., 236, 491  
 AKROUT M., 268, 321, 324, 341, 510  
 AL KADIRI K., 271  
 ALBERTSEN K., 270  
 ALEM M.E.R., 198, 232, 450  
 ALEXANDRE N.M.C., 71, 332, 398, 445  
 ALPTEKIN K., 352  
 ALVES H., 259  
 AMICK B.C., 17, 68, 69, 70, 154, 284, 302, 373, 393, 418, 477  
 AMRI C., 268, 321, 324, 341, 510  
 ANDERSEN A.D., 217  
 ANDERSEN C.H., 387  
 ANDERSEN G.R., 137  
 ANDERSEN J.H., 217, 478, 481  
 ANDERSEN L.L., 387  
 ANDLAUER C., 470  
 ANEMA J.R., 78, 162  
 ANTLE D.M., 239  
 ANTON D., 65  
 ARABI. F.H., 396  
 ARCHAMBAULT C., 468  
 ARENDT-NIELSEN L., 376  
 ARIAL M., 322  
 ARISAKA M., 260  
 ARMSTRONG T.J., 136, 313  
 ARSENAULT M., 298  
 ARVIDSSON I., 140, 236, 491  
 ASSELIN A., 406  
 ASUNDI K., 287, 288, 289  
 ATAIN KOUADIO J.J., 206  
 ATEN S., 220  
 AUBLET-CUVELIER A., 206, 214, 219, 390, 411  
 AUTHIER M., 51  
 AUVINEN J., 100  
 AZAM K., 220  
 BACHMANN R.H., 386  
 BACKX A., 446  
 BADAOUI S., 432, 472, 473  
 BAELUM J., 353  
 BAKER N.A., 213, 290, 291  
 BALASUBRAMANIAN V., 180  
 BALOGH I., 138, 139, 140, 236, 334, 491  
 BANKS J., 126, 178  
 BAO S.S., 115  
 BAPTISTA P.C.P., 323  
 BARATTI A., 265  
 BARBE M.F., 169  
 BARBEAU E., 211  
 BARIL-GINGRAS G., 98  
 BARNEKOW-BERGVIST M., 429  
 BARR A., 63  
 BARR A.E., 169  
 BARREIRA T.H.C., 514  
 BARRERO L.H., 181, 371  
 BATTIÉ M.C., 388  
 BAZZANI L., 69  
 BEALES, 305  
 BEAR, 305  
 BEATON D.E., 284, 454, 455, 477  
 BEAUMONT D., 397  
 BEGHADLI B., 512  
 BELLEMARE M., 98  
 BELLIES L., 164  
 BEN KHADIJA J., 341  
 BENOÎT D., 322  
 BENRFORT L., 424  
 BERG K., 257  
 BERGMANN A., 488



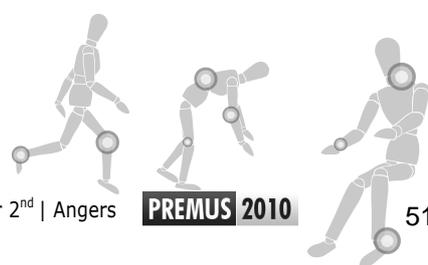
- BERKOWITZ J., 458  
 BERNMARK E., 292  
 BEROLO S., 373  
 BERTHELETTE D., 47, 49  
 BIDRON P., 402, 442  
 BIELEMAN H.J., 382  
 BIGELOW P., 165, 284  
 BILODEAU H., 49  
 BINDERUP A.T., 376  
 BIRTLES M., 90  
 BJERKEDAL T., 43  
 BJÖRKLUND M., 429, 456  
 BLATTER B.M., 267, 283, 420, 504  
 BLOOD R.P., 240  
 BLOSWICK D., 117, 118  
 BODIN J., 442, 485  
 BOITEL L., 403  
 BOLM-AUDORFF U., 370, 488  
 BOMBARDIER C., 454, 455  
 BONAUTO D.K., 115  
 BONETTI F., 467  
 BONFIGLIOLI R., 374  
 BONGERS P.M., 62, 162  
 BONTOUX L., 452  
 BOOCOOCK M.G., 251, 360  
 BORCH H., 182  
 BORD E., 486  
 BORG V., 270  
 BORIE-MALAVIEILLE M.J., 432, 472, 473  
 BOSCHMAN J.S., 56  
 BOSTRÖM M., 440  
 BOUILLON B., 383  
 BOULOT M., 403  
 BOUTON C., 439  
 BOUWMAN C., 378  
 BOUZGAROU L., 510  
 BOUZGARROU L., 268  
 BOYER J., 308, 326  
 BOYSEN M., 387  
 BRADL I., 245  
 BREWER S., 393  
 BRIERE J., 149  
 BRIQUET-WAGNER A., 470  
 BROSSET N., 470  
 BROUWER S., 68, 76, 152, 153, 425, 431, 436, 437, 462  
 BRUDER R., 221, 257  
 BRUNO J.L., 267, 286, 293, 333  
 BRUUSGAARD D., 102  
 BUCHBINDER R., 388  
 BUCHHOLZ B., 210  
 BUCHHOLZ F., 470  
 BUCHMANN W., 164, 468  
 BÜLTMANN U., 68, 70, 80  
 BURDORF A., 316, 378, 404  
 BURGEL B.J., 263  
 BURGESS R.A., 294  
 BURGESS-LIMERICK R., 304  
 BURSTRÖM L., 175, 338  
 BURT S., 114  
 CAIL F., 214  
 CALABRESE M., 374  
 CALFEE R.P., 35, 377  
 CALVET B., 498  
 CAMACHO A.M., 181  
 CAMPBELL, 305  
 CAMPBELL-KYUREGHYAN N., 215, 295, 340  
 CAMPO M., 310  
 CANJUGA M., 460  
 CARLAN N., 165  
 CARNAZ L., 183  
 CAROLY S., 53, 95, 143, 511  
 CARRASQUILLO V., 313  
 CASTILLO J.A., 184  
 CAVALCANTE E., 514  
 CEBALLOS C., 181, 371  
 CESARI B., 34  
 CHAARI N., 321, 324, 341, 510  
 CHAIKUMARN M., 186  
 CHAISE F., 36  
 CHAKRAVARTY T., 278  
 CHAN C.C., 281



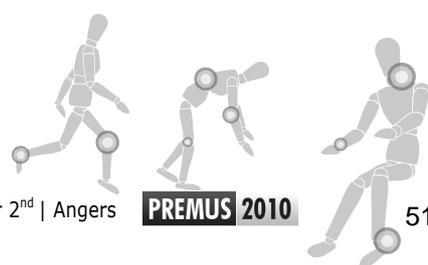
- CHANG J.C., 328  
 CHANNELL T., 278  
 CHASSAING K., 163  
 CHASTANG J.F., 36, 485  
 CHEIKH MHAMED A., 268  
 CHEN B.B., 84  
 CHEN C.H., 84  
 CHENG S.W.K., 320  
 CHERAY I., 143  
 CHERNIACK M., 159  
 CHESKY K., 342  
 CHEVEREZ-RODRIGUEZ N.E., 325  
 CHIH-WEI L., 222  
 CHI-LING H., 222  
 CHOI S.J., 266  
 CHRISTENSEN J.R., 158, 385  
 CIRIELLO V.M., 126, 389, 394  
 CLARK B.D., 169  
 CLAUDON L., 206, 216  
 CLOT Y., 390, 411  
 COGGON D., 33, 365  
 COLE D., 94, 284, 417  
 COLUCI M.Z.O., 398  
 COMMISSARIS D.A.C.M., 242  
 COMTOIS A.-S., 280  
 CONVERSO D., 265  
 COOMES J., 359  
 COOPER K., 215, 295  
 CORBEIL P., 244, 312  
 CÔTÉ J.N., 129, 239, 493  
 CÔTÉ P., 75, 454  
 COURY H.J.C.G., 400  
 COUTAREL F., 45, 143, 163, 511  
 COYLE J., 410  
 CPH-NEW RESEARCH TEAM., 159  
 CRENSHAW A.G., 121, 125  
 CROMBIE K., 114  
 CROOK J.M., 458  
 CUI L., 299  
 CURTI M., 467  
 CURTI S., 467  
 D'ARCY H., 361  
 D'ERRICO A., 265  
 DACKUTE A., 273  
 DAINOFF M., 328  
 DALDON M.T.B., 475  
 DALE A.M., 35, 60, 119, 205, 212, 359, 361, 367, 377  
 DANIELLOU F., 27, 511  
 DANUSER B., 322, 460, 474  
 DAVID A., 383  
 DAVILMAR A., 40  
 DAVIS K.G., 399, 423  
 DE BOER W.E.L., 76  
 DE BRUIJNE M.C., 419  
 DE KRAKER H., 87  
 DE OLIVEIRA C., 79, 418  
 DE RANGO K., 69  
 DE SERRES S.J., 493  
 DE VET H.C.W., 78  
 DECKOW-SCHAEFER G., 117  
 DEDDENS J., 114  
 DEGUISE J., 189  
 DEHDASHTI A.R., 401  
 DELISLE A., 187, 188, 235, 280  
 DELLVE L., 440  
 DELORE-MILLES E., 470  
 DEMENT J.M., 58, 331, 421  
 DENIS D., 94, 187, 188, 235, 249  
 DENNERLEIN J.T., 181, 267, 279, 286, 287, 288, 289, 293, 304, 328, 333, 393  
 DEPARIS P., 296  
 D'ERRICO A., 196  
 DESARMENIEN A., 402, 403  
 DESBROSSES K., 243  
 DESCATHA A., 35, 36, 359, 377, 485, 512  
 DEVARENNE V., 469  
 DEYCH E., 119  
 DIAS N.B., 400  
 DICK R.B., 482  
 DICKERSON C.R., 173  
 DIDRY G., 203, 243  
 DIJKSTRA P.U., 425



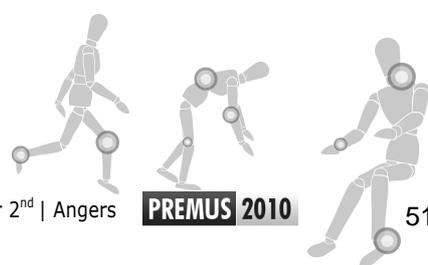
- DITCHEN D.M., 380, 488  
 DJUPSJÖBACKA M., 456  
 DODA D., 415  
 DOLINSCHI R., 79, 418  
 DOUBRE S., 397  
 DOUPHRATE D.I., 108, 109, 112, 200, 335  
 DOUWES M., 87, 242  
 DRIBAN J., 278  
 DRIESSEN M.T., 78, 162  
 DROSSAERS-BAKKER K.W., 382  
 DUBUS V., 452  
 DUDAS K., 142  
 DUGUE B., 96, 163  
 DUHALDE D., 280  
 DUMAS J.P., 493  
 DUNNING K.K., 423  
 DUPERY M., 403  
 DUPREZ H., 444  
 DURAND M.J., 47, 49, 457, 466  
 EBELING H., 100  
 EECKELAERT L.E., 504  
 EIJCKELHOF B.H.W., 267  
 EINSIEDLER K., 182  
 EISEN E., 116  
 EKBERG K., 138, 139, 424, 438  
 EKMAN A., 492  
 EKTOR-ANDERSEN J., 158  
 ELCADI G.H., 121, 125  
 ELDERS L.A.M., 404  
 ELÍAS-BONETA A., 325  
 ELLEGAST R.P., 204, 257, 371, 380, 414, 488  
 ELLIOTT M.B., 169  
 ELSNER G., 370, 488  
 EMERY K., 129, 493  
 ENBERG B., 261  
 ENGLUND J.E., 111  
 ENGLUND M., 480  
 ERIKSEN H.R., 156  
 ERIKSSON P.O., 250, 441  
 ESCOBAR L.C., 507  
 ESCRIVA E., 405, 511  
 EVANOFF B., 35, 60, 119, 205, 212, 359, 361, 367, 377, 393  
 FABER A., 158  
 FALLENTIN N., 168  
 FAN Z.J., 115  
 FANELLO S., 512  
 FANI A., 250  
 FARRAND D.J.E., 471  
 FASSIER J.B., 466  
 FAUCHEUX D., 296  
 FELLI V.E.A., 323  
 FERNANDEZ G., 390, 411  
 FERNÁNDEZ-CARNERO J., 376  
 FERRARI C., 467  
 FERRARI R., 388  
 FERREIRA J.J., 90  
 FERRIER S., 74  
 FETHKE N.B., 335  
 FISCHER F.M., 262  
 FISCHER S.L., 173  
 FJELLMAN-WIKLUND A., 342, 501  
 FLENGHI D., 435  
 FORSMAN M., 121, 141, 177, 207, 246, 292  
 FORTINEAU E., 231  
 FOUQUE P.A., 34  
 FOUQUET B., 432, 472, 473  
 FOUQUET N., 149, 486  
 FRANCHE R.L., 74, 75, 78, 153, 454  
 FRANCISCO K.R., 232  
 FRANZBLAU A., 35, 119, 212, 359, 361, 377, 393  
 FRAY M., 319  
 FRENS M.A., 277  
 FRILANDER H., 42  
 FRINGS-DRESEN M.H.W., 56, 59, 64, 366, 378, 426, 427  
 FROST P., 217, 368, 369  
 FRYKMAN M., 342  
 FUGLSANG-FREDERIKSEN A., 368, 369  
 FULLER J.R., 129, 493  
 FULMER S., 326  
 GAALICHE A., 268  
 GAGNON D., 188, 235



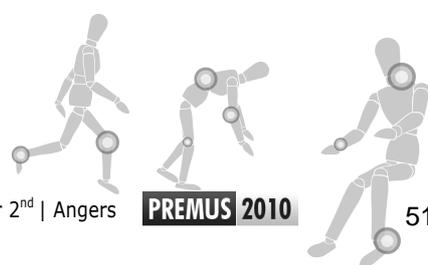
- GALASSO L., 343  
 GALLAGHER S., 194  
 GALLASCH C.H., 71  
 GARABET A., 328, 394  
 GARG A., 117, 118, 309, 392  
 GARRABE H., 337  
 GARRITANO E., 165, 226  
 GAUDEZ C., 219, 390, 411  
 GAUDREAUULT N., 189  
 GEBHARDT H., 379, 383  
 GEERTZEN J.H.B., 76, 152, 425, 431, 436, 437, 462  
 GELL N., 358  
 GERDLE B., 190  
 GERONIMI M., 193  
 GERR F., 393  
 GETTENS J.W., 465  
 GHAFOURI B., 190  
 GHASEMKHANI M., 220  
 GHEZEL-AHMADI K., 221  
 GHOMARI O., 512  
 GHRAM R., 321  
 GIGNAC M.A.M., 455  
 GIL COURY H.J.C., 183, 198, 409, 450  
 GILLEN M., 263  
 GIMENES M.J.F., 262  
 GINLEY B., 408  
 GIORDANO P.C.M., 445  
 GLINA D.M.R., 262, 329, 343  
 GLITSCH U., 257  
 GLUTTING J.J., 366  
 GOLD J.E., 278, 366  
 GOLDBERG M., 485, 486  
 GOLDBERG R., 116  
 GONELLA M., 94, 249  
 GONIK V., 474  
 GÖRAN LINDBERG L., 123  
 GORCE P., 191  
 GOUBAUD S., 406  
 GOUTTEBARGE V., 59, 378, 426  
 GRAF M., 483  
 GRAHAM G.B., 234  
 GRAM B., 158, 386  
 GRANQVIST L., 236  
 GRAY M.I., 89, 90  
 GRAZIOSI F., 374  
 GRIFFITHS R.F., 360  
 GRIFKA J., 488  
 GRIGORIU I., 515  
 GROOTEN W., 310  
 GROOTHOFF J.W., 76, 152, 382, 431, 436, 437, 462  
 GROSS D.P., 388, 443  
 GUILLOUX V., 231  
 GUNN S., 330  
 GUNNAR WALLIN B., 197  
 GUO Y.L., 84  
 GUSTAFSSON E., 492  
 GUSTAFSSON M., 395  
 GÜTSCHOW S., 245  
 HA C., 36, 149, 442, 446, 485, 486, 516  
 HAAHR J.P., 478, 481  
 HABIBI E., 344  
 HADREVI J., 190  
 HAERTING J., 488  
 HAGBERG M., 197, 440, 492  
 HAGEMEISTER N., 189  
 HAGERT C.G., 111  
 HALL V., 298  
 HALLMAN D., 123, 250  
 HAMAOU A., 193  
 HAMBERG J., 429  
 HAMMER C., 122  
 HAMRICK C., 423  
 HAN C., 279  
 HAN Y.S., 228  
 HANDRIGAN G.A., 244  
 HANLON A., 366  
 HANNERZ H., 387  
 HANSEN C.L., 80  
 HANSSON G.Å., 140, 217, 236, 334, 395, 491  
 HANVOLD T.N., 179, 282



- HARLIN U., 142  
 HARRIS C., 116, 297  
 HARTIGAN A., 358  
 HARTMANN B., 245, 380, 447  
 HASSIF H., 470  
 HAUKKA E., 101  
 HAWKES L., 408  
 HEGMANN K.T., 117, 118, 309  
 HEIDEN M., 246, 429  
 HEINRICH J., 420  
 HELGESSON M., 227  
 HELIÖVAARA M., 363, 490  
 HELLER-ONO A.R., 513  
 HELLMAN M., 298  
 HELLSTRÖM F., 190  
 HENCHI M.A., 268  
 HENRY A.D., 465  
 HERMANN S., 327  
 HERMANS V., 86  
 HERMENS H.J., 131, 157  
 HERNANDEZ-ARELLANO J.L., 354  
 HESS J., 65  
 HEWITT A., 330  
 HIGNETT S., 319  
 HIMMELSTEIN J.S., 465  
 HO P., 320  
 HOEHNE-HUECKSTAEDT U., 371  
 HOEHNE-HUECKSTAEDT U.M., 204  
 HOFFMEISTER K., 407  
 HOFMANN F., 488  
 HOGG N., 306  
 HOGG-JOHNSON S., 40, 75, 153, 454  
 HOLLANDER A., 504  
 HOLM J.C.W., 353  
 HOLTE K.A., 269, 416  
 HOLTERMANN A., 70, 158, 170, 385, 386  
 HOLTERMANN P., 132  
 HOOZEMANS M.J.M., 247, 285, 420, 448  
 HOPCIA K., 333  
 HOWARD N., 115  
 HSU H.C., 84  
 HU J., 313  
 HU R., 388  
 HUANG Y.H., 151  
 HUIS IN 'T VELD M.H.A., 157  
 HULST VAN DER M., 131  
 HUNG Y.J., 84  
 HURLEY K., 237  
 HUSGAFVEL-PURSIAINEN K., 82, 83  
 HUUNAN-SEPPÄLÄ A., 105  
 HUYSMANS M.A., 267, 283, 286  
 HVITVED M., 122  
 HWANG Y.H., 84, 300  
 IHA S., 154  
 IHLEBÆK C.M., 102  
 ILIADOU A., 253, 364  
 IMBEAU D., 94  
 IMBERNON E., 149, 442, 485, 486  
 INCORVAIA A.M., 403  
 IORDACHE R., 515  
 IRVIN E.L., 79, 393, 417, 418  
 ISOMURA T., 260  
 ISOSAKI M., 329  
 ISSEVER H., 352  
 JACOBS K., 298  
 JAEGERS L.A., 60, 205, 367  
 JAGANNATH M., 180  
 JÄGER M., 314, 348, 488  
 JANG S.H., 508  
 JANNIS J., 349  
 JANOWITZ I., 63  
 JANUÁRIO L. B., 350  
 JANWANTANAKUL P., 375  
 JAREBRANT C., 142  
 JARLE MORK P., 132  
 JÄRVHOLM B., 338  
 JEANCOLAS B., 403  
 JEBENS E., 433, 434  
 JEENA J., 275  
 JENSEN B.R., 122, 336  
 JENSEN J.C., 478, 481  
 JENSEN J.N., 270



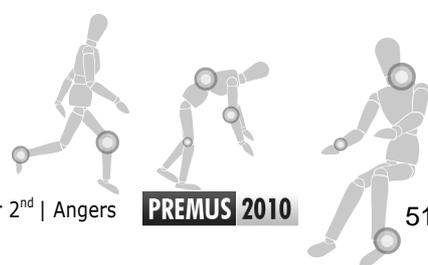
- JEON H.J., 266  
 JEUDI J., 34  
 JIAMJARASRANGSI W., 375  
 JIANG D., 454  
 JIN Y., 114  
 JOHANSSON E., 223, 224, 227  
 JOHANSSON HANSE J., 142  
 JOHNSEN B., 368, 369  
 JOHNSON P., 279, 287, 288, 289, 304  
 JOHNSON P.W., 240, 267, 299  
 JOHNSTON V., 307, 410  
 JOLING C.I., 62  
 JONKER D., 138, 139  
 JORDAN C., 314  
 JØRGENSEN M.B., 158, 170  
 JORONEN H., 460  
 JOSEPHSON M., 223, 224, 227, 463  
 JÖUD A., 480  
 JULA A., 490  
 KÄÄRIÄ S., 103  
 KAGECHIKA K., 441  
 KÄHÖNEN M., 83  
 KAILA-KANGAS L., 42  
 KALDENBERG J., 298  
 KALSO E., 105  
 KAMALERI Y., 102  
 KANCHANOMAI S., 375  
 KANDOUCCI A.B., 512  
 KANG D.M., 428, 499  
 KANG J.W., 248  
 KANTOMAA M., 100  
 KAPELLUSCH J., 117, 118, 309, 392  
 KAPRIO J., 105  
 KARPPINEN J., 100, 490  
 KATZ J., 154  
 KENNEDY C.A., 393  
 KENNY D.T., 461  
 KEOWN K., 417  
 KERN F., 474  
 KEYSERLING W.M., 358  
 KHALFALLAH T., 268, 321, 324, 341, 510  
 KHAVANIN A., 401  
 KIELKOWSKI D., 315  
 KILSGAARD J., 80  
 KIM K.S., 345  
 KIM Y.H., 428, 499  
 KIM Y.K., 428, 499  
 KING T., 284, 302  
 KIRKESKOV L., 57, 384  
 KJELLBERG K., 223, 224, 227  
 KLIPSTEIN A., 460  
 KLUSSMANN A., 379, 383  
 KNARDAHL S., 124, 128, 269  
 KNIBBE J.J., 316  
 KNOL D.L., 162  
 KNUTSEN O., 433, 434  
 KOEHOORN, 255  
 KOLSTRUP C.L., 108, 109, 110  
 KOMATSU M.O., 232  
 KOO J.W., 248  
 KOPPELAAR E., 316  
 KOPPEL L.L.J., 448  
 KOSKENVUO K., 105  
 KOSKENVUO M., 105  
 KOSNY A., 74  
 KOTOWSKI S.E., 423  
 KRAIEM R., 268  
 KRAKER de H., 242, 504  
 KRAMER D.M., 165  
 KRAUS T., 507  
 KRAUSE N., 75, 116, 153, 263  
 KRIEBEL D., 211  
 KRIEG E.F., 482  
 KRISTENSEN P., 43  
 KRISTMAN V.L., 264  
 KUIJER P.P.F.M., 64, 426  
 KUROWSKI A., 210, 326  
 LAAKSONEN M., 103  
 LAATIKAINEN T., 489  
 LABERGE M., 52  
 LABRIOLA M., 269, 416  
 LAEUBLI T., 460



- LAHELMA E., 103  
 LAHIRI S., 66  
 LAMPA E., 227  
 LANCMAN S., 459, 475, 476  
 LANDRY A., 143  
 LANDRY L., 500  
 LANG K.H., 252  
 LARIVIÈRE C., 188, 235  
 LARMER P.J., 360  
 LARSSON B., 190  
 LATZA U., 494  
 LÄUBLI T.H., 176, 483  
 LAULAN J., 472  
 LE CAPITAINE C., 98  
 LECLERC A., 36, 485, 486  
 LEDENVIC B., 442  
 LEDUC N., 49  
 LEE D.L., 276  
 LEE H., 75, 153  
 LEE H.J., 347  
 LEE H.K., 508  
 LEE K.H., 346  
 LEE M.Y., 266  
 LEHTIMÄKI T., 83  
 LEIJON O., 39, 463  
 LEINO-ARJAS P., 101, 103, 104, 105  
 LELAND-WIATROWSKI N., 298  
 LEPERS R., 199  
 LEROUX F., 442  
 LEROYER A., 271  
 LETZEL S., 507  
 LEVESQUE S., 219  
 LEWIS C., 175  
 LEY K., 313  
 LI Z., 293  
 LI Z.M., 291  
 LIANG H.W., 300  
 LIEBERS F., 88, 225, 379, 383, 494  
 LIIRA H., 363  
 LIMA N., 451  
 LIMA,L.B., 451  
 LIN J.H., 178, 449  
 LIN P.H., 301  
 LINDBERG P., 463  
 LINDEGÅRD A., 395  
 LINDHOLM H., 171  
 LINHARDT O., 488  
 LINTON S.J., 73, 151  
 LIOU S.H., 84, 347  
 LIPPEL K., 74  
 LIPSCOMB H.J., 58, 311, 318, 331, 421  
 LIV P., 209  
 LOCKEY J., 423  
 LOISEL P., 47, 78, 457, 466  
 LOMBARDI D.A., 212  
 LOMBRAIL P., 486  
 LOMOND K.V., 493  
 LORTIE M., 249  
 LOUIS N., 191  
 LÖVE J., 492  
 LU C.W., 301  
 LUND T., 80, 269, 416  
 LUNDQVIST P., 108, 109  
 LUSA S., 171  
 LUTAM B., 349  
 LUTTMANN A., 314, 348, 488  
 LYSKOV E., 123, 250  
 MA L.P., 84  
 MACDERMID J., 454, 477  
 MACEACHEN E., 74  
 MADELEINE P., 130, 192, 376, 502  
 MAHFOUDHI A., 268, 510  
 MAHLBERG R., 414  
 MAHOOD Q., 393  
 MAIKALA R.V., 126  
 MAIRIAUX P., 29, 506  
 MAJOR M.E., 339  
 MÄKINEN T., 171  
 MALINAUSKAITE I., 272  
 MALINAUSKIENE V., 273  
 MAMEN A., 433, 434  
 MANERO R., 274



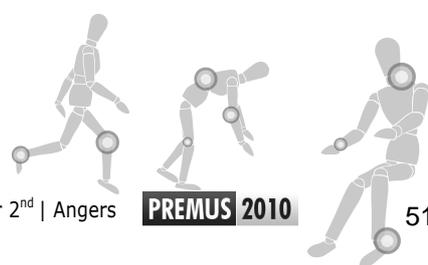
- MANNICHE C., 353  
 MANSYUR M., 349  
 MARINELLI F., 374  
 MARINHO-SILVA A., 514  
 MARKKULA R., 105  
 MARKLUND S., 416  
 MARKOWITZ J., 298  
 MARSHALL J., 237  
 MARSOT J., 216  
 MARTINS A.C., 323  
 MARTINS K.C., 232  
 MATHANKUMAR M., 275  
 MATHIASSEN S.E., 177, 207, 208, 209, 246, 255, 277, 413  
 MATSMOTO R., 514  
 MATSUDAIRA K., 260  
 MATTIOLI S., 467  
 MAWSTON G.A., 251  
 MAY J., 408  
 MAYTON A.G., 194  
 MAZOYER A., 442  
 McGORRY R.W., 178  
 MCGORRY R.W., 449  
 McNAIR P.J., 360  
 MCNAIR P.J., 251  
 MEDBØ J.I., 433, 434  
 MEHLUM I.S., 43  
 MENDES L.F., 459, 476  
 MERCHAOU I., 268, 321, 324  
 MERITET F., 442  
 MERLIN X., 405  
 MERRYWEATHER A., 117, 118  
 MESSING K., 52, 239, 498  
 METIVIER J.C., 432, 472, 473  
 MEYER J.P., 203, 243, 435  
 MICHAELIS M., 327, 488  
 MIEDEMA H.S., 316  
 MIKOCZY Z., 480  
 MILLER C., 360  
 MILNER R., 458  
 MIRANDA H., 42  
 MIRANDA L.C.J., 350  
 MIRKA G.A., 58  
 MOCHEL J.L., 206  
 MOEHLING K., 213, 290, 291  
 MOHAN BABU R., 453  
 MOILANEN L., 363  
 MOLINIE A.F., 271  
 MOLLER A., 416  
 MONNINGTON S.C., 89  
 MONTENEGRO-VIDAL J., 356  
 MOORE A.E., 226  
 MOORE J.S., 117  
 MOORE S.M., 194, 422  
 MORAIS. A., 396  
 MOREIRA R.F.C., 400  
 MORIGUCHI C.S., 183, 450  
 MORTAZAVI S.B., 401  
 MORTENSEN O.S., 158  
 MORTENSEN P., 387  
 MOTTURA B., 265  
 MUEHLEMEYER C., 252  
 MUENSTER E., 507  
 MUIJZER A., 76  
 MULDER M., 39, 253, 364  
 MÜLLER C.H., 176, 483  
 MUSSONI P., 374  
 MUTH D., 206  
 MUZEAU B., 259  
 MYERS D.J., 311, 318, 331, 421  
 NABE-NIELSEN K., 270  
 NAHON P., 231  
 NAKASEKO M., 176  
 NAKATA M., 441  
 NAQVI S., 517  
 NASTASIA I., 97, 188, 235  
 NATVIG B., 102  
 NAYHA S., 489  
 NEGRETE-GARCIA M.C., 354  
 NELSON C., 74  
 NEUMANN B., 252  
 NEUMANN W.P., 141



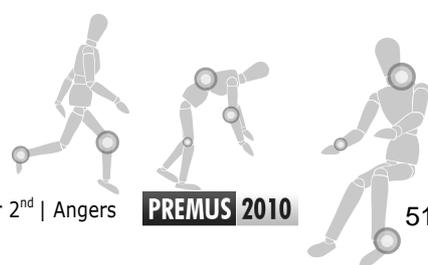
- NGUYEN T., 330  
 NILSING E., 464  
 NILSSON A., 456  
 NILSSON T., 338  
 NOH S.K., 266  
 NOKHBEZAIM M., 371  
 NOLAN J., 58  
 NONNENMANN M.W., 335  
 NORBERG M., 460  
 NORDANDER C., 140, 236, 334, 480, 491  
 NYANTUMBU B.M., 315  
 NYMAN T., 253, 364  
 O'BRIEN N.V., 126  
 O'DAY E., 333  
 O'SULLIVAN, 305  
 ÖBERG B., 424, 438, 464  
 OCHSMANN E.B., 507  
 ODELL D.L., 276  
 OHLSSON K., 140, 236, 334, 491  
 ÖHMAN A., 261  
 OJAJÄRVI A., 101  
 OKSA J., 171  
 OLIVEIRA A.B., 195, 198, 350, 409  
 OLSEN J., 80  
 OOSTERVELD F.G.J., 382  
 OPDEBEECK R., 504  
 OROZCO. A., 184  
 ORR R.M., 410  
 ORTA-ANÉS L., 325, 399  
 ØSTENSVIK T., 202  
 OUDE HENGEL K.M., 62  
 OUELLET S., 161  
 OVERGAARD K., 158, 385  
 ÖZCAN E., 352  
 PAANANEN M., 100  
 PAARUP H.M., 353  
 PADULA R.S., 451  
 PALM P., 223, 224, 227  
 PALMER K.T., 365  
 PALMERUD G., 141  
 PARISE F., 397  
 PARK J., 308  
 PARK J.K., 228, 508  
 PAROT-SCHINKEL E., 36  
 PASANISI C., 467  
 PATIL A., 112  
 PATTERSON D., 58  
 PAVLOSKY W.F., 294  
 PAWLOWSKA Z., 504  
 PEARSON I., 493  
 PEDERSEN M.M., 387  
 PEDERSEN M.T., 387  
 PEDROSA-DOMELLÖF F., 190  
 PEHKONEN I., 391  
 PELLIEUX S., 432, 472, 473  
 PENSRI P., 375  
 PENTTI J., 104  
 PERES C.C., 514  
 PERKIÖ-MÄKELÄ M.M., 484  
 PERSSON J., 424  
 PETEREIT-HAACK G., 370, 488  
 PETIT J., 96  
 PETIT LE MANAC'H A., 452, 486, 516  
 PETITPAS C., 296  
 PETTERSSON I.F., 480  
 PHILLIPS L.A., 443  
 PICHONNAZ L., 322  
 PIEDRAHITA H.H., 371  
 PIENIMAKI T., 489  
 PIERRO M., 196  
 PIETTE A., 86, 95  
 PILIGIAN G., 366  
 PILLASTRINI P., 467  
 PINSKE S., 108  
 PINZKE S., 109, 110  
 PISANIELLO D., 415  
 PLAINE J., 149  
 PLAMONDON A., 187, 188, 235, 244  
 PLAT M.J., 427  
 PODZHAROVA E., 356  
 POLLARD J.P., 194, 422  
 POLLOCK C., 297



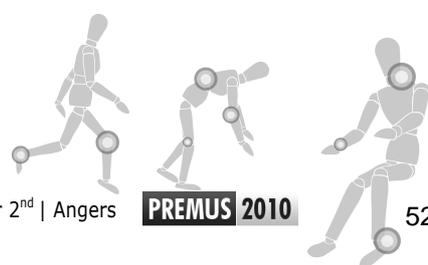
- POMMIER J.L., 271  
 POMPEII L.A., 331, 421  
 POON J.T.C., 320  
 POPE R., 410  
 PORTER W.L., 194  
 PORTERO P., 259  
 POULIN P., 98  
 POURMAHABADIAN H., 229  
 POURMAHABADIAN M., 229, 230  
 PRAIRIE J., 312  
 PRANSKY G., 37, 73, 151  
 PRECHAC A., 469  
 PRKACHIN K.M., 458  
 PROPER K.I., 62, 162  
 PROTEAU R.A., 495  
 PULIDO J.A., 371  
 PUNNETT L., 159, 210, 308, 326  
 QUARRIE C., 89  
 QUINN M., 211  
 QUINTANA L.A., 181, 371  
 QUIROS E., 383  
 QUIROS PEREA E., 379  
 RABARIN F., 34  
 RAIMBEAU G., 34, 36  
 RAINA S., 293  
 RAITAKARI O.T., 82, 83  
 RAMESHKUMAR R., 275, 453  
 RAMOND A., 439  
 RAMSEY J., 114  
 RANGEL-SALAZAR R., 356  
 RASSAS I., 324  
 RAT DE COQUARD M., 403  
 RATHORE H., 355, 496  
 RAZZAGHINIA N., 229  
 RECHARDT M., 490  
 REES D., 315  
 REMPEL D., 25, 116, 393  
 REMPEL D.M., 63  
 RENEMAN M.F., 152, 382, 425, 431, 436, 437, 462  
 RENO G., 214  
 REYNOLDS S.J., 108, 109  
 RICHARD I., 439, 452, 516  
 RICHARD M.C., 457  
 RICHARDS R.R., 454  
 RICHTER J.M., 277  
 RIEGER M.A., 182, 379, 380, 383  
 RIEL J., 498  
 RIGGS R., 313  
 RIIHIMÄKI H., 101  
 RINTAMÄKI H., 171, 489  
 RISSANEN S., 171  
 RITTNER R., 236, 480, 491  
 RIVARD A.J., 126, 389  
 RIVEST K., 493  
 ROATTA S., 196  
 ROBERTSON M., 69  
 ROBERTSON M.M., 328, 394  
 ROCHA L.E., 262, 329, 343, 514  
 ROCHE-LEBOUCHER G., 452  
 RODRÍGUEZ L.E., 181  
 RODRIGUEZ T., 274  
 RODRIGUEZ Y., 254  
 RØE C., 416  
 ROESSLER K.K., 387  
 ROLANDER B., 138, 139  
 ROMAN-LIU D., 504  
 ROQUELAURE Y., 36, 149, 442, 485, 486, 511, 512, 516  
 ROSECRANCE J.C., 108, 109, 112, 200, 335, 362, 407  
 ROSGAARD C., 336  
 ROSS J., 98  
 ROTHMORE P., 330, 415  
 ROWLAND M., 408  
 RUSSELL A.S., 388  
 RYNELL P.W., 240  
 RYTTER S., 57, 384  
 SAASTAMOINEN P., 103  
 SADEGHI-NAEENI H., 230  
 SADLER E.M., 234  
 SAINT-CAST Y., 34  
 SALAS E.A., 226



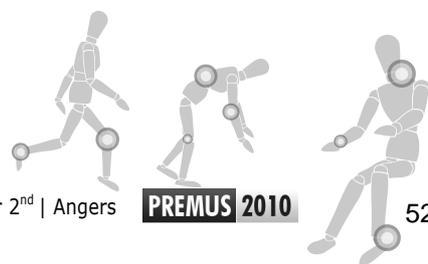
- SALAZAR E., 187, 188, 235, 280  
 SAMANI A., 192, 376  
 SANCHEZ-OBREGON R.A., 354  
 SANDELL C., 342  
 SANDÉN H., 197  
 SANDFELD J., 336  
 SANDSJÖ L., 138, 139  
 SANTOS M.C., 475  
 SATO T.O., 232  
 SAVESCU A., 390, 411  
 SAWADA T., 260  
 SCHAAFSMA F., 461  
 SCHAEFER A., 252  
 SCHAEFFER G., 118  
 SCHAUB K., 221  
 SCHAUB K.H., 257  
 SCHMIDT K.H., 348  
 SCHOENFISCH A.L., 311, 318, 331, 421  
 SCHOHN M., 470  
 SCHONSTEIN E., 78, 461  
 SCHOPFLOCHER D., 388  
 SCHULTZ Z., 458  
 SCHWATKA N.V., 407  
 SCHWEITZER J.M., 511  
 SEIDEL D., 447  
 SEIDLER A., 370, 488, 494  
 SELL L., 70  
 SEMBAJWE G., 211  
 SERACIN M., 515  
 SERAZIN C., 442  
 SERRA C., 393  
 SERRANHEIRA F., 233  
 SERRATOS-PÉREZ J.N., 354, 356  
 SEVERIN C., 75, 284  
 SHANAHAN C., 226  
 SHARAN D., 275, 453  
 SHAW W.S., 73, 151, 153, 389, 449  
 SHERSON D., 80  
 SHIH T.S., 347  
 SHIH T.T.F., 84  
 SHIMABUKURO V.G.P., 332  
 SHIN D.H., 266  
 SHIRI R., 82, 83, 363, 490  
 SHU-KEI CHENG A., 430  
 SIEBERS S., 392  
 SILLAM F., 446  
 SILVA L.C.C.B., 198  
 SILVÉRIO O.L., 195  
 SILVERSTEIN B., 18, 115, 148, 505  
 SIMMONDS M., 360  
 SIMONEAU M., 244  
 SIMONET P., 390, 411  
 SINGH S., 355, 496  
 SINWAL N., 355, 496  
 SIQUEIRA A.R., 329  
 SJØGAARD G., 20, 158, 386, 387  
 SKAUGEN B.H., 416  
 SKERFVING S., 140, 236, 491  
 SKOTTE J., 170  
 SLIJPER H.P., 277  
 SLUITER J.K., 56, 59, 366, 426, 427  
 SMITH, 305  
 SMITH A., 297  
 SMITH C.K., 115  
 SÖDERBERG E., 464  
 SOER R., 425, 436  
 SØGAARD K., 70, 158, 170, 385, 386  
 SOLOVIEVA S., 82, 83  
 SOMMERICH C., 295  
 SOMVILLE P.R., 506  
 SOTELO-BARROSO F., 356  
 SOTO L., 274  
 SOUSA-UVA A., 233  
 SOUVLIS T., 307  
 SPEKLÉ E.M., 285, 420  
 STÅL M., 108, 109, 111  
 STAR D., 63  
 STEENSTRA I., 40, 73, 284, 302  
 STEINBERG U., 88, 225  
 STENBERG G., 501  
 STERDYNIAK J.M., 397  
 STEVENSON J.M., 234



- STEWART M.H., 346  
 STEWART S., 415  
 STOCK S., 147  
 STODDARD A., 211  
 STRAKER, 305  
 STRAKER L., 297, 304  
 STRØM V., 124  
 STRÖMBERG U., 236, 491  
 ST-VINCENT M., 94, 97, 188, 235, 249  
 SU S.B., 301  
 SUAREZ N., 181  
 SUNDELIN G., 175, 261  
 SURER N., 486  
 SVARTENGTREN M., 253, 364  
 SVENDSEN J.H., 192, 502  
 SVENDSEN S.W., 217, 368, 369  
 SVENSSON E., 138  
 SZETO G.P.Y., 281, 320  
 TAANILA A., 100  
 TAIMELA S., 100  
 TAKALA E.P., 101, 391  
 TAKATALO K., 171  
 TALEB M., 512  
 TAMMELIN T., 100  
 TANG K., 454, 455, 477  
 TAPPIN D., 360  
 TARIN C., 469  
 TASSY V., 442  
 TAYLOR-GARDNER B.T., 212  
 TEASDALE N., 244  
 TEKAVEC E., 480  
 TELAMA R., 82  
 TESCHKE K., 255  
 TESSLER J., 308  
 The Evrest National Project Team Members, 271  
 The Manu Group, 187  
 The Promoting Healthy and Safe Employment in  
 Healthcare Team, 308  
 THEILMEIER A., 314  
 THEUREL A., 199  
 THEUREL J., 199  
 THIBAULT J.F., 405  
 THIESE M., 117, 118, 309  
 THOMAS N., 278  
 THOMÉE S., 440, 492  
 THOMPSON R.T., 294  
 TILSON T., 360  
 TING A.C.W., 320  
 TOLDRÁ R.C., 475  
 TOMATIS L., 176  
 TOMPA E., 79, 418  
 TOOMINGAS A., 207, 246  
 TORRES Y., 254  
 TOULOUSE G., 97, 280  
 TOURANCHET A., 442  
 TOUSSAINT J.F., 470  
 TRASK C.M., 208, 255  
 TREMBLAY-BOUDREAU V., 77  
 TREUTLEIN D., 504  
 TREVELYAN F., 360  
 TRUDEAU M., 293  
 TSAI S., 347  
 TSANG R.C.C., 320  
 TUNTLAND H., 416  
 TURPIN-LEGENDRE E., 203  
 TURTURICI M., 196  
 TVEITO T.H., 156  
 TWISK J.W.R., 448  
 TZEMPARILIDIS N., 250  
 UDTAMADILOK T., 333  
 UEGAKI K., 419  
 ULVESTAD E., 461  
 UNGE J., 236  
 UTTERSTRÖM K., 250  
 UYSAL B., 352  
 VAF AEI A., 264  
 VAHTERA J., 104  
 VAN DEN BERG T.I.J., 404  
 VAN DEN HEUVEL S.G., 504  
 VAN DER BEEK A.J., 48, 162, 267, 283, 378,  
 419, 420  
 VAN DER KLINK J.J.L., 68



- VAN DER MOLEN H.F., 56, 59, 64  
 VAN DER SCHANS C.P., 425  
 VAN DIEËN J.H., 247, 267, 285, 378, 420, 448  
 VAN EERD D., 284, 302, 393, 417  
 VAN MECHELEN W., 78, 419  
 VAN OOSTROM S.H., 78  
 VAN TRIER M., 390, 411  
 VAN TULDER M., 419, 420  
 VAN VELDHOVEN M., 450  
 VAN WEERING M., 131, 157  
 VEIERSTED K.B., 128, 177, 179, 202, 207, 282, 433, 434  
 VELEZ-SANTORI C.N., 325  
 VERBEEK J., 40  
 VERBEEK J.H., 461  
 VÉZINA N., 14, 77, 161, 239, 339, 457  
 VI P., 165, 226  
 VIKARI J., 82, 83, 363  
 VIKARI-JUNTURA E., 22, 42, 82, 83, 101, 115, 363, 490  
 VILLALOBOS E., 189  
 VILLALOBOS G., 371  
 VIÑA S., 254  
 VINGÅRD E., 409  
 VIOLANTE F.S., 374, 467  
 VIOSSAT M., 403  
 VIOTTI S., 265  
 VIRAGH E., 357  
 VIRAGH H., 357  
 VISSER B., 247  
 VOLKHINA G., 356  
 VOLKOFF S., 164, 271, 468  
 VOLLENBROEK-HUTTEN M.M.R., 131, 157  
 VON ENGELHARDT L.V., 383  
 VRIES de H.J., 431, 437, 462  
 VYAS REKHA, 412  
 WADDELL G., 388  
 WAERSTED M., 179, 282  
 WÅHLIN NORNGREN C., 438  
 WÅHLIN NORNGREN L., 424  
 WAHLSTRÖM J., 39, 338, 497  
 WAI-CHEE CHENG S., 430  
 WAKEFIELD E., 132  
 WAKULA J., 257  
 WALKER B., 298  
 WALLACE W.N., 200  
 WANG G.H., 347  
 WANG T.M., 84  
 WANG Y., 279  
 WANG Y.L., 281  
 WANMAN A., 250  
 WASIAK R., 443  
 WATERS T.R., 91, 482  
 WEBER B., 414  
 WEDDERKOPP N., 353  
 WELCH L.S., 65, 66  
 WELLS R., 46, 93, 165, 173, 237, 306, 373  
 WERNER R., 358  
 WERNSTEDT P., 310  
 WERTSCH J., 118  
 WESTGAARD R.H., 135, 137  
 WHELAN K.M., 461  
 WHITE M., 263  
 WIGGERMAN N., 358  
 WIITAVAARA B., 456  
 WIJK K., 413  
 WIKTORIN C., 253, 292, 364  
 WILD P., 322  
 WILLIAMS R., 393  
 WINCKEL M., 469  
 WIND H., 426  
 WINKEL J., 135, 138, 139, 141, 142  
 WIOLAND L., 219  
 WOISZWILLO M., 389  
 WONG R.C.K., 517  
 WONG T.L., 307  
 WOOD E., 117  
 WUEST E., 298  
 WURZELBACHER S., 114  
 WYCKOFF S., 408  
 XIU K.H., 213, 290, 291  
 YAMADA Y., 441  
 YANG D.J., 428, 499, 503



YANG S.H., 84  
YANG Y.A., 503  
YOON J., 201, 238  
YOSHIZAWA M., 441  
YOUNG A.E., 443

YU D., 313  
ZANA J.P., 259  
ZEBIS M.K., 387  
ZITTING P., 100

