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Aims

Carpal Tunnel Syndrome (CTS) represents one of the most significant and costly health problems occurring in the worldwide working population. Prevalence rates of CTS vary between 2.7% and 5.8% in the general population and reach 10% or more in specific occupations.

Epidemiological studies have identified several combinations of personal and work-related risk factors for CTS, but few have reported associations between the work organization and CTS.

The aim of this study was **to examine the risk factors for incident CTS in workers representative of a French region's working population, with a special focus on factors related to work organization and management practices.**



Methods

This prospective study was based on epidemiological surveillance data collected by a network of 168 (83 at baseline + 85 at follow-up) occupational physicians (OPs) in the working population of the Loire Valley region (West-Central France). All OPs were trained by the investigators to perform a standardized physical examination.

Subjects

- **3,710 workers** [2,161 men (58%) and 1,549 women (42%), mean age of 38.7 years \pm 10.3 years] were randomly selected by 83 OPs from workers undergoing a mandatory regularly-scheduled annual health examination between **2002 and 2005**.
- 1,611 workers were re-examined in **2007-2010: 1,532 workers** without CTS at baseline and without a missing value for the diagnosis of CTS (baseline/follow-up).

Outcome

- Case definition of CTS based on symptoms only ("symptomatic CTS"), whether physical examination signs were positive or not.
- Symptom criteria for CTS were the presence of symptoms on the day of the medical examination (or for at least 4 days during the preceding 7 days) including intermittent paresthesia or pain in at least two of the first three digits; either of these also being present at night (causing pain in the palm, wrist, or radiating proximal to the wrist).
- Physical examination signs criteria: at least one positive flexion and compression test, carpal compression test, Phalen's test and Tinel's test (Sluiter et al, 2001).

Personal and work-related characteristics

A self-administered questionnaire including personal and work-related characteristics was filled out by workers.

Statistical method

- Relationships between CTS and potential risk factors were studied by binary logistic regression modelling only on workers without CTS at baseline:
 - Analyses were performed with each of the factors related to the work organization adjusted for gender, and non-significant variables (p-value \geq 0.20) were excluded from further analyses.
 - All remaining variables were included in a global multivariate logistic regression model (adjusted for gender, age and biomechanical factors) until a final model was selected; only significant variables with a p-value $<$ 0.10 were retained.

Results

- The follow-up rate did not differ with gender (42.6% for men *vs.* 44.5% for women) or baseline occupational category. However, fewer temporary workers and workers in the agriculture sector were re-examined.

- 59 incident "symptomatic CTS" (3.9% [2.9-4.8]) were diagnosed among the 1,532 workers without CTS at baseline. The incidence was higher in women than men (5.9% [4.1-7.7] *vs.* 2.4% [1.4-3.4], $p < 0.001$). Physical signs were present in 11 men (1.2% [0.6-2.2]) and 25 women (3.9% [2.4-5.3], $p < 0.001$).
- The risk of "symptomatic CTS" was higher for women (OR = 2.9 [1.7-5.2]) and increased linearly with age (OR = 1.04 [1.00-1.07] for 1-year increment).
- Two characteristics of the work organization and management practices remained in the multivariate risk model after adjustment for the personal/medical and biomechanical factors (Table): work pace dependent on automatic rate (OR = 1.9 [0.9-4.1]) and payment on a piecework basis (OR = 2.0 [1.1-3.5]).
- Similar associations were observed for CTS defined by symptoms and signs on physical examination: work pace dependent on automatic rate (OR=2.3, 95% CI [1.0-5.6]) and payment on a piecework basis (OR=3.0, 95% CI [1.5-5.9]).

Table: Multivariate models of risk factors for symptomatic CTS in the working population

FACTORS RELATED TO THE WORK ORGANIZATION (yes/no)	Model 1*					Model 2**				
	N _{sample}	N _{CTS}	OR	95% CI	p-value	N _{sample}	N _{CTS}	OR	95% CI	p-value
Paced work	139	5	1.0	0.4-2.7	0.940					
Work pace dependent on:										
Automatic rate	148	10	2.3	1.1-4.7	0.021	134	10	1.9	0.9-4.1	0.090
Technical organization	313	11	1.1	0.6-2.2	0.737					
Customers' demands	703	24	0.8	0.5-1.4	0.435					
Colleagues' work	416	21	1.7	1.0-3.0	0.062					
Quantified targets	685	30	1.4	0.8-2.4	0.177					
Permanent controls	366	11	0.8	0.4-1.5	0.421					
Work with temporary workers	415	21	1.6	0.9-2.7	0.111					
Overtime hours	903	37	1.3	0.8-2.2	0.352					
Variable weekly workload	814	32	1.2	0.7-2.0	0.585					
No prior knowledge of the workload	146	4	0.9	0.3-2.5	0.830					
Payment on a piecework basis	320	21	2.3	1.3-4.0	0.003	309	19	2.0	1.1-3.5	0.024
Job/task rotation (\geq 1 job rotation per week)	542	22	1.1	0.6-1.9	0.780					

*Model 1 adjusted for gender.

**Model 2 adjusted for gender, age, biomechanical factors [number of risk factors (0, 1, 2+) including use of vibrating hand tools (\geq 2 hours/day), exposure to cold temperature (\geq 4 hours/day), holding tools/objects in a pinch grip (\geq 2 hours/day), extreme wrist bending posture (\geq 2 hours/day), pressing with palm base (\geq 2 hours/day) and force (VAS $>$ 5)] and factors related to the work organization. Number of subjects = 1421; Number of "symptomatic CTS" = 55. p-value (Hosmer-Lemeshow) = 0.300.

Discussion

- Work organization factors relate to the structural task and/or organizational-level aspects of the work process. This study was one of the very first showing an association between CTS and factors related to the work organization (work pace dependent on automatic rate) and management practices (payment on a piecework basis), after adjustment for the main personal/medical and biomechanical risk factors. This was observed not only for symptomatic CTS, but also for CTS defined more strictly (symptoms and positive signs on physical examination). The importance of the factors related to work organization is not diminished by the relative impact of biomechanical factors, such as exposure to pressing with the base of the palm and cold temperature.
- In conclusion, this epidemiological study confirms that in addition to mechanical exposure, work organizational constraints should be an important target for prevention strategies of CTS in the working population.