

Job strain and neck–shoulder symptoms: a prevalence study of women and men white-collar workers

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Background	Neck–shoulder symptoms are frequent among workers. Psychosocial factors at work have been associated with neck–shoulder symptoms, but few studies have examined job strain, the combined effect of high psychological demands (PD) and low decision latitude (DL).
Aims	To examine the association between psychosocial factors at work and the prevalence of self-reported neck–shoulder symptoms among white-collar workers.
Methods	In a cross-sectional study of 1543 white-collar workers, PD and DL at work were measured with Karasek's questionnaire. Prevalent cases were workers for whom neck–shoulder symptoms were present for ≥ 3 days during the previous 7 days and for whom pain intensity was greater than half the visual analogue scale. Gender and social support at work were evaluated as potential effect modifiers.
Results	Workers exposed to high job strain had a higher prevalence of neck–shoulder symptoms [adjusted prevalence ratio (PR): 1.54, 95% confidence interval (CI): 1.00–2.37]. No modifying effect of gender was observed in this association. The effect of job strain was stronger in workers with low social support (adjusted PR: 1.84, 95% CI: 0.92–3.68). These associations tended to be stronger and/or more precise when using alternative exposures and case definition. Namely, a stronger job strain effect was observed when a tertile cut-off was used to classify exposure (adjusted PR: 2.47, 95% CI: 1.15–5.32).
Conclusion	These results suggest that primary prevention of neck–shoulder symptoms among white-collar workers should consider the exposure to job strain, especially when workers are exposed to low social support at work.
Key words	Neck pain; psychosocial factors; stress; work; workload.

Introduction

Neck–shoulder symptoms are frequent among workers. Depending on the case definition and population studied, the reported 1-year prevalence of neck symptoms in occupational settings ranges from 6 to 76% [1]. Neck symptoms are more common among women than men

[1–6]. Considering the high prevalence of neck–shoulder symptoms, it is important to identify their most important risk factors, particularly those that can be modified.

A number of studies suggest that some adverse psychosocial factors at work are associated with neck and/or shoulder symptoms [2,5–10]. A recent review found some evidence for poor social support at work, low job control and high psychological demands (PD) as independent factors for neck pain. However, the evidence for a relationship between high job strain and neck pain was inconclusive [11].

According to the Karasek model, workers exposed to high job strain, a combination of high PD and low decision latitude (DL) are at higher risk of developing diseases [12]. Moreover, high social support at work may attenuate the negative effect of high job strain [13]. However, few studies on neck and/or shoulder symptoms have

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examined the combined effect of high PD and low DL [6,10,14]. Even fewer studies have evaluated whether social support at work modifies the association between job strain and neck and/or shoulder symptoms [2,5].

The main objective of this cross-sectional study was to examine the association between psychosocial factors at work (PD, DL, social support, job strain) and the prevalence of self-reported neck-shoulder symptoms. Secondary objectives were to determine whether gender or social support at work modified the association between job strain and the prevalence of neck-shoulder symptoms.

Methods

A cross-sectional study was conducted in Quebec City, Canada. All white-collar workers employed in two large public service organizations including various worksites were invited to participate. Their jobs encompassed the full range of white-collar jobs, including senior and middle managers, professionals, technicians and office workers. In each worksite, the data were collected in a short time-frame (<1 year). Overall data collection was done between June 2000 and June 2003. Participants provided informed consent. They were met at their worksite during working hours and completed a self-administered questionnaire on work organization factors, health and socio-demographic variables. Height and weight were also measured.

Psychological job demands (9 items, range 11–34) and job DL (9 items, range 26 to 96) were measured using Karasek's questionnaire [15], whose psychometric qualities for both the original English [16–18] and French versions [16,19,20] have been demonstrated. PD refers to the quantity of work, the time constraints and the level of intellectual effort required. DL refers to the opportunities to make decisions, to be creative and to use and develop one's abilities at work. High and low categories for PD and DL were determined by a cut-off point corresponding to the median of the total score for each of these constraints among a reference population. This reference population was composed of a representative sample of all workers in the province of Quebec [21]. Social support at work was measured with the Karasek's questionnaire which contains 11 items [15]. Social support was dichotomized at the median of the distribution of a large sample of white-collar workers from 21 different organizations in Quebec City. Most previous studies on these psychosocial factors have also used the median cut-off [22]. Job strain was defined as a combination of PD and DL, which served to classify workers into four exposure groups: (i) the high-strain group—workers exposed to both high PD and low DL (PD+, DL–), (ii) a moderately exposed group—workers exposed to high PD but having high DL (PD+, DL+), (iii) another moderately exposed group—those exposed to low DL but having low PD

(DL–, PD–) and (iv) the reference group—workers with low PD combined with high DL (PD–, DL+).

Other cut-off points for job strain have been tested in complementary analyses to verify whether they would lower misclassification. One definition used the median of PD and DL of the current sample to dichotomize, and another formulation considered the tertiles.

Prevalent cases were workers for whom neck-shoulder symptoms were present for ≥ 3 days during the previous 7 days and for whom pain intensity was greater than half the visual analogue scale (VAS). The neck-shoulder area was indicated by a manikin. This instrument has been used in a previous study to measure self-reported musculoskeletal symptoms [23] and has shown good concordance with musculoskeletal problems evaluated by physical examination [24]. A less restrictive case definition has also been considered in complementary analyses. This definition identified prevalent cases as those workers who had symptoms in the neck-shoulder area for ≥ 1 day and for whom pain intensity was greater than half the VAS. Previous studies have defined musculoskeletal disorder cases according to pain intensity (at least moderate) and symptom duration such as in the National Institute for Occupational Safety and Health case definition [25–27].

In addition to social support at work, gender was considered as a potential effect modifier. Age, education, smoking, leisure-time physical activity, body mass index (BMI), job category, seniority in the current job, number of hours worked per day on a video display unit (VDU), number of hours worked weekly in the current job, usual physical activity at work and stressful life events during the prior 12 months were evaluated as potential confounders. Domestic load was measured taking into account the number of children and the sharing of family responsibilities and domestic chores; the total score of this index was divided in tertiles. Neck rotation was assessed by the lateral position of the screen: (i) in front of the worker, (ii) to the right side, (iii) to the left side and (iv) not exposed (working <4 h/day on a VDU). An index considering monitor height and wearing of bifocals was created to evaluate whether the visual target was optimal or not among those working ≥ 4 h/day on a VDU. An optimal visual target was defined as (i) eye level at the top of the screen when not wearing bifocals or (ii) eye level higher than the top of screen when wearing bifocals.

The prevalence of self-reported neck-shoulder symptoms and bivariate associations with the study population's characteristics were generated. Binomial regression models were used to evaluate the association between each psychosocial factor at work and the prevalence of neck-shoulder symptoms [28]. As a first step, the relationships between each psychosocial factor at work and neck-shoulder symptoms were studied one at a time in bivariate analyses. As a second step, all other factors were introduced in multivariate models. Only confounding

factors [change in prevalence ratios (PRs) $\geq |10\%|$] were kept in the final models except for age, which was forced in the models. In a third step, all psychosocial factors at work studied (PD, DL and social support) were included at the same time in the model. The potential modifying effect of gender or social support at work was evaluated for the job strain model. All statistical analyses were performed using SAS software, version 8.1. A *P*-value of 0.05 was defined as the criterion for statistical significance.

Results

Of the 2258 potentially eligible workers, 1834 (81%) agreed to participate. Workers with rheumatoid arthritis or spondylitis ($n = 72$) and those with a history of acute injury in the neck–shoulder area ($n = 219$) were excluded from the analyses, leaving a study population of 1543 subjects, 63% of whom were women. The median age was 43 years among women (inter-quartile range = 9.0) and 45 years among men (inter-quartile range = 11.0). Women had worked a median of 2.35 years in the current job (inter-quartile range = 7.1) and men had worked a median of 3.7 years (inter-quartile range = 8.9).

Table 1 shows the number of individuals and the prevalence of self-reported neck–shoulder symptoms by selected characteristics of the study population. Bivariate associations between self-reported neck–shoulder symptoms and these characteristics are also presented. Women reported a much higher prevalence of neck–shoulder symptoms than men [PR: 2.26, 95% confidence interval (CI): 1.71–2.97]. Workers with a lower education level, those with a higher domestic load and those who had experienced two or more stressful events during the previous year had a higher prevalence of neck–shoulder symptoms. Technicians and office workers were more likely to report symptoms than executives and professionals. Neck–shoulder symptoms were also more common among those working on a VDU ≥ 6 h/day, especially if the VDU screen was at their left side and if the visual target was not optimal.

In the multivariate analyses, PD were associated with neck–shoulder symptoms (Table 2). DL and social support at work, taken as single variables, were not associated with the outcome. However, workers exposed to high PD and low DL (high job strain) had an elevated prevalence of neck–shoulder symptoms compared to those with low PD and high DL. Workers exposed to high PD and high DL did not show a significant increase in the prevalence of symptoms.

No modifying effect of gender was observed on the association between job strain and neck–shoulder symptoms (Table 3). Men and women had similar PRs. On the other hand, the job strain analysis stratified for the level of social support at work showed that the association with job strain was mainly observed in workers with low social support (Table 4).

Other definitions of job strain have been used in complementary sensitivity analyses to verify whether other cut-offs would lower misclassification (Table 5). Dichotomizing DL and PD at the median of the current sample to define high-strain group (PD ≥ 23 , DL ≤ 70) instead of using the median of the reference population (PD ≥ 24 , DL ≤ 72) reduced the proportion of workers exposed and increased the associations with neck–shoulder symptoms (adjusted PR: 1.78, 95% CI: 1.11–2.84). A substantially greater association was observed for workers exposed to high job strain and low social support (adjusted PR: 2.53, 95% CI: 1.14–5.66). Another formulation of job strain using the higher tertile of PD (PD > 25) and the lower tertile of DL (DL ≤ 64) also produced a higher association between high job strain and neck–shoulder symptoms (adjusted PR: 2.47, 95% CI: 1.15–5.32), but there was an insufficient number of prevalent cases to stratify the analyses by gender or social support.

An additional sensitivity analysis was also performed to test a less restrictive definition of prevalent cases (Table 5). Considering prevalent cases as those who had symptoms in neck–shoulder area for ≥ 1 day (instead of ≥ 3 days) and for whom pain intensity was greater than half the VAS produced comparable or slightly higher PRs with significant CIs for workers exposed to high job strain (adjusted PR for PD+DL–: 1.64, 95% CI: 1.13–2.39) and for workers exposed to high job strain and low social support (adjusted PR: 1.98, 95% CI: 1.08–3.62).

Discussion

In this cross-sectional study, PD, evaluated as a single factor, were associated with neck–shoulder symptoms. Workers exposed to high job strain, i.e. the combination of high PD and low DL, had a higher prevalence of symptoms. Social support at work was not directly associated with the outcome, but the effect of job strain was stronger in workers with low social support at work.

This study has a number of strengths. It was conducted in a large sample of women and men. The reasonably high response rate (81%) limited the potential for a selection bias. PD and DL at work were evaluated with a validated French version of the Karasek Job Content Questionnaire. Reanalysis of the data with the five-item version of PD [16] produced similar results. The measurement of neck–shoulder symptoms was done with a previously validated instrument. A large number of potential confounders were taken into account. Finally, the potential modifying effect of gender and of social support at work was evaluated.

Nonetheless, the current study has several limitations. The cross-sectional design limits causal inferences. Given that these results are from the baseline data collected in the context of a prospective study, it will be possible to

Table 1. Prevalence of self-reported neck-shoulder symptoms and bivariate associations with selected characteristics of the study population ($n = 1543$)

Variables	n (missing)	Prevalence	PR (95% CI)
Gender	(0)		
Men	578	9.7	1.00
Women	965	21.9	2.26 (1.71–2.97)
Age	(0)		
<35 years	211	17.1	1.00
35–44 years	614	16.8	0.98 (0.70–1.39)
45–64 years	718	17.8	1.04 (0.75–1.46)
Level of education completed	(1)		
University	599	13.9	1.00
College	483	18.6	1.34 (1.02–1.77)
<College	460	20.4	1.47 (1.13–1.93)
Domestic load	(58)		
Low	521	14.0	1.00
Moderate	445	16.6	1.19 (0.88–1.60)
High	519	21.6	1.54 (1.18–2.01)
Smoking	(5)		
No	1298	16.9	1.00
Yes	240	20.0	1.19 (0.90–1.57)
Leisure-time physical activity	(7)		
>1× per week	705	16.7	1.00
≤1× per week	831	17.7	1.06 (0.85–1.32)
BMI	(19)		
<30	1270	17.3	1.00
≥30	254	17.3	1.00 (0.75–1.34)
Stressful life events past 12 months			
0	770	15.3	1.00
1	505	17.2	1.12 (0.87–1.45)
≥2	268	23.1	1.51 (1.15–1.99)
Job category	(4)		
Executive/professional	558	13.3	1.00
Technician/office worker/other	981	19.7	1.48 (1.16–1.90)
Number of years in current job	(22)		
<3	779	17.5	1.00
≥3	742	16.9	1.03 (0.83–1.29)
Hours per week working in current job	(6)		
≤35	1249	17.7	1.00
>35	288	15.6	0.88 (0.66–1.18)
Hours per day working on VDU	(13)		
<6	756	14.9	1.00
≥6	774	19.8	1.32 (1.06–1.65)
Neck rotation	(112)		
Screen in front	1044	16.6	1.00
Screen on the right side	68	16.2	0.98 (0.56–1.71)
Screen on the left side	72	26.4	1.59 (1.06–2.40)
Not exposed (<4 h on VDU)	247	15.0	0.90 (0.65–1.25)
Visual target on VDU	(64)		
Optimal	449	14.3	1.00
Nonoptimal	783	19.7	1.38 (1.06–1.80)
Not exposed (<4 h on VDU)	247	15.0	1.05 (0.72–1.53)
Usual physical activity at work	(9)		
Frequent moving without lifting load	437	17.2	1.00
Sitting most of the time	1069	17.4	1.01 (0.79–1.29)
Standing position/lifting load	28	17.9	1.04 (0.46–2.36)

Results in bold type are statistically significant.

evaluate the temporal relationship between psychosocial factors at work and neck-shoulder symptoms in a future study. A possible selection bias from a healthy worker's effect cannot be excluded. Since the analyses were limited

to participants who were currently working, workers who had left the job market because of sickness may have been excluded. Other participants may have switched to a less exposed job in order to reduce exposure to high PD or

Table 2. Non-adjusted and adjusted associations between psychosocial factors at work and neck–shoulder symptoms

	<i>n</i> (missing)	Prevalence (%)	PR _{non-adj} (95% CI)	PR _{adj} ^a (95% CI), <i>n</i> = 1490	PR _{adj} ^b (95% CI), <i>n</i> = 1476
PD	(9)				
Low	806	15.0	1.00	1.00	1.00
High	728	20.1	1.34 (1.07–1.66)	1.44 (1.15–1.80)	1.46 (1.16–1.84)
DL	(12)				
High	564	15.1	1.00	1.00	1.00
Low	967	18.7	1.24 (0.98–1.57)	1.04 (0.80–1.34)	1.10 (0.84–1.43)
Social support	(13)				
High	667	15.6	1.00	1.00	1.00
Low	863	18.8	1.20 (0.96–1.51)	1.18 (0.94–1.48)	1.14 (0.90–1.44)
Job strain	(15)				
PD–, DL+	210	12.9	1.00	1.00	1.00
PD–, DL–	592	15.7	1.22 (0.82–1.82)	1.06 (0.69–1.62)	1.03 (0.67–1.58)
PD+, DL+	353	16.4	1.28 (0.84–1.95)	1.37 (0.89–2.13)	1.35 (0.87–2.10)
PD+, DL–	373	23.6	1.83 (1.23–2.73)	1.61 (1.05–2.45)	1.54 (1.00–2.37)

Results in bold type are statistically significant.

–: low, +: high.

^aEach psychosocial factor at work was evaluated in a separate model, one at a time, and was adjusted for age, gender, education, stressful life events that occurred during the past 12 months, job category, number of years in the current job, hours worked daily on a VDU and usual physical activity at work.

^bAdjusted for variables included in Model 1, PD, DL and social support at work.

Table 3. Non-adjusted and adjusted PRs, and 95% CI, for the association between job strain and neck–shoulder symptoms, according to gender

Job strain	Men			Women		
	PR _{non-adj} (95% CI)	PR _{adj} ^a (95% CI)	PR _{adj} ^b (95% CI)	PR _{non-adj} (95% CI)	PR _{adj} ^a (95% CI)	PR _{adj} ^b (95% CI)
<i>n</i>		558	554		934	927
PD–, DL+	1.00	1.00	1.00	1.00	1.00	1.00
PD–, DL–	1.48 (0.68–3.21)	1.35 (0.58–3.14)	1.43 (0.60–3.38)	0.99 (0.63–1.57)	0.94 (0.58–1.53)	0.91 (0.56–1.47)
PD+, DL+	0.98 (0.42–2.32)	1.13 (0.46–2.78)	1.16 (0.47–2.86)	1.32 (0.82–2.14)	1.34 (0.82–2.18)	1.30 (0.80–2.13)
PD+, DL–	1.54 (0.67–3.53)	1.61 (0.67–3.84)	1.70 (0.70–4.13)	1.62 (1.03–2.54)	1.50 (0.93–2.41)	1.40 (0.86–2.28)

Results in bold type are statistically significant.

^aAdjusted for age, education, stressful life events that occurred during the past 12 months, job category, number of years in the current job and hours worked daily on a VDU.

^bAdjusted for variables included in Model 1 and social support at work.

low DL and/or because of health problems [29]. This potential selection bias has most likely led to an underestimation of the true associations [29].

Another potential limitation of this study is the use of self-reported indicators for musculoskeletal symptoms. However, the instrument used in the current study has shown good concordance with musculoskeletal problems evaluated by physical examination [24]. Physical demand was also measured by self-report using a general question about usual physical activity at work rather than by objective measures. Nevertheless, it is reasonable to assume that there is little variability among these white-collar workers in terms of physical demand. In addition, the analysis controlled for time worked daily on a VDU and for some postural stressors.

All the complementary sensitivity analyses performed to assess the association between job strain and neck–shoulder symptoms resulted in comparable or higher associations than those presented in the main results and had significant CIs in adjusted models. This indicates that our main analyses likely underestimate the true strength of the associations. In addition, given that most suspected potential confounders were accounted for in the analyses, it seems unlikely that the associations observed could be due to unmeasured factors, although it cannot be ruled out.

In the current study, the prevalence of neck–shoulder symptoms was substantially higher among women (21.9%) than men (9.7%), which is consistent with previous studies [1–6,30–32]. These prevalences are also

Table 4. Non-adjusted and adjusted PRs, and 95% CI, for the association between job strain and neck-shoulder symptoms, according to social support at work

Job strain	High social support		Low social support	
	PR _{non-adj} (95% CI)	PR _{adj} ^a (95% CI)	PR _{non-adj} (95% CI)	PR _{adj} ^a (95% CI)
<i>n</i>		646		830
PD-, DL+	1.00	1.00	1.00	1.00
PD-, DL-	1.19 (0.72-1.97)	0.93 (0.52-1.64)	1.39 (0.69-2.80)	1.12 (0.55-2.26)
PD+, DL+	1.00 (0.57-1.73)	1.07 (0.60-1.92)	1.76 (0.86-3.63)	1.64 (0.80-3.37)
PD+, DL-	1.35 (0.76-2.39)	1.14 (0.61-2.12)	2.35 (1.18-4.66)	1.84 (0.92-3.68)

Results in bold type are statistically significant.

^aAdjusted for age, gender, education, stressful life events that occurred during the past 12 months, job category, number of years in the current job, hours worked daily on a VDU and usual physical activity at work.

Table 5. Sensitivity analyses of alternative classifications of exposure and symptoms

Types of analyses	Adjusted PR ^a and 95% CI, high/low job strain	Adjusted PR ^b and 95% CI, high/low job strain among workers exposed to low social support at work
Main analysis		
Median cut-off of the reference population, symptoms ^c ≥ 3 days	1.54 (1.00-2.37)	1.84 (0.92-3.68)
Sensitivity analyses		
Median cut-off of the current sample, symptoms ^c ≥ 3 days	1.78 (1.11-2.84)	2.53 (1.14-5.66)
Tertile cut-off of the current sample, symptoms ^c ≥ 3 days	2.47 (1.15-5.32)	Insufficient prevalent cases ^d
Median cut-off of the reference population, symptoms ^c ≥ 1 day	1.64 (1.13-2.39)	1.98 (1.08-3.62)
Median cut-off of the current sample, symptoms ^c ≥ 1 day	1.74 (1.18-2.58)	2.34 (1.24-4.45)

^aAdjusted for age, gender, education, stressful life events that occurred during the past 12 months, job category, number of years in the current job, hours worked daily on a VDU, usual physical activity at work and social support at work.

^bAdjusted for age, gender, education, stressful life events that occurred during the past 12 months, job category, number of years in the current job, hours worked daily on a VDU and usual physical activity at work.

^cThe definition of prevalent cases also required that the intensity of pain be greater than half of the VAS.

^dNumber of prevalent cases insufficient to stratify by social support.

comparable to the findings of previous studies conducted among working populations [3,4,31]. As in the present study, the number of children (a proxy for domestic load) [33], elevated number of hours worked on a VDU [34] and neck rotation [35] have been associated with neck symptoms in the literature. Neck-shoulder symptoms were not associated with age, smoking, leisure-time physical activity or BMI as observed in other studies [2,36,37]. The replication, in the current study, of findings from previously documented risk factors supports data validity.

The present results suggest an association between PD and neck-shoulder symptoms, which is consistent with previous studies [2,7,8,10]. On the other hand, few studies on neck and/or shoulder symptoms have examined the job strain model [6,10,14]. In line with Karasek's job

strain model [12], we found that workers in the high-strain group had the highest prevalence of neck-shoulder symptoms. Two previous cross-sectional studies have reported an association between job strain and the prevalence of neck symptoms [6,10], whereas one previous study did not find this association [14].

No significant gender difference was found (no interaction) in the association between job strain and neck-shoulder symptoms. Possible comparison of these results with other studies is limited, as very few studies have evaluated the potential modifying effect of gender on this association. In a previous cross-sectional study conducted among 9496 Quebec workers, gender differences were noted [6] where high job strain was associated with an elevated prevalence of neck pain in women, but not in men. However, in that study, both white- and blue-collar

workers were included in the analyses, which may explain the difference observed.

Assessment of the potential modifying effect of social support at work (Table 4) revealed higher PRs among workers exposed to low social support. This is consistent with the theoretical model [12]. A modifying effect of social support at work on the relationship between job strain and neck, shoulder and upper back symptoms has also been observed in one previous study, although the modifying effect of social support at work was observed mainly in the intermediate exposure groups [5].

These findings show that combined exposure to PD, DL and social support at work produces a more appropriate evaluation of psychosocial factors at work than assessing each factor independently when evaluating the factors associated with the prevalence of neck-shoulder symptoms. This is important to consider for primary prevention of these frequent musculoskeletal symptoms.

In conclusion, the results of this study showed that workers with high PD combined with low DL at work had a higher prevalence of neck-shoulder symptoms than other workers, especially when exposed to low social support at work. These findings support the hypothesis of the Karasek demand-control-support model. Prospective studies are needed to measure the effect of these psychosocial exposures on neck-shoulder symptoms.

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Conflicts of interest

None declared.

References

- Ariens G, Borghouts J, Koes B. Neck pain. In: Crombie IK, Croft PR, Linton SJ, LeResche L, Von Korff M, eds. *Epidemiology of Pain*. Seattle: IASP Press, 1999; 235–255.
- Andersen JH, Kaergaard A, Frost P *et al*. Physical, psychosocial, and individual risk factors for neck/shoulder pain with pressure tenderness in the muscles among workers performing monotonous, repetitive work. *Spine* 2002;**27**:660–667.
- de Zwart B, Frings-Dresen M, Kilbom A. Gender differences in upper extremity musculoskeletal complaints in the working population. *Int Arch Occup Environ Health* 2001;**74**:21–30.
- Palmer KT, Walker-Bone K, Griffin MJ *et al*. Prevalence and occupational associations of neck pain in the British population. *Scand J Work Environ Health* 2001;**27**:49–56.
- Wahlstedt KG, Björkstén MG, Edling C. Factors at work and musculoskeletal symptoms among postal workers. *Int J Behav Med* 2001;**8**:181–193.
- Leroux I, Dionne CE, Bourbonnais R, Brisson C. Prevalence of musculoskeletal pain and associated factors in the Quebec working population. *Int Arch Occup Environ Health* 2005;**78**:379–386.
- Ariens GA, Bongers PM, Hoogendoorn WE, Houtman IL, van der Wal G, van Mechelen W. High quantitative job demands and low coworker support as risk factors for neck pain: results of a prospective cohort study. *Spine* 2001;**26**:1896–1901.
- Lagerstrom M, Wenemark M, Hagberg M, Hjelm EW. Occupational and individual factors related to musculoskeletal symptoms in five body regions among Swedish nursing personnel. *Int Arch Occup Environ Health* 1995;**68**:27–35.
- Nahit ES, Hunt IM, Lunt M, Dunn G, Silman AJ, Macfarlane GJ. Effects of psychosocial and individual psychological factors on the onset of musculoskeletal pain: common and site-specific effects. *Ann Rheum Dis* 2003;**62**:755–760.
- Toomingas A, Theorell T, Michelsen H, Nordemar R, Stockholm MUSIC I Study Group. Associations between self-rated psychosocial work conditions and musculoskeletal symptoms and signs. *Scand J Work Environ Health* 1997;**23**:130–139.
- Ariens G, van Mechelen W, Bongers P, Bouter L, van der Wal G. Psychosocial risk factors for neck pain: a systematic review. *Am J Ind Med* 2001;**39**:180–183.
- Karasek RA, Theorell T. *Healthy Work: Stress, Productivity and the Reconstruction of Working Life*. New York: Basic Books, 1990.
- Johnson JV, Hall EM, Theorell T. Combined effects of job strain and social isolation on cardiovascular disease morbidity and mortality in a random sample of the Swedish male working population. *Scand J Work Environ Health* 1989;**15**:271–279.
- Ahlberg-Hulten G, Theorell T, Sigala F. Social support, job strain and musculoskeletal pain among female health care personnel. *Scand J Work Environ Health* 1995;**21**:435–439.
- Karasek R. *Job Content Questionnaire and User's Guide: Department of Industrial and Systems Engineering*. University of Southern Los Angeles, California, 1985.
- Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol* 1998;**3**:322–355.
- Karasek R. Lower health risk with increased job control among white collar workers. *J Organ Behav* 1990;**11**:171–185.
- Karasek RA, Schwartz J, Pieper C. *Validation of a Survey Instrument for Job-Related Cardiovascular Illness*. New York: Department of Industrial Engineering and Operations Research, Columbia University, 1983.
- Brisson C, Blanchette C, Guimont C, Dion G, Moisan J, Vézina M. Reliability and validity of the French version of

- the 18-item Karasek Job Content Questionnaire. *Work Stress* 1998;12:322-336.
20. Larocque B, Brisson C, Blanchette C. Cohérence interne, validité factorielle et validité discriminante de la traduction française des échelles de demande psychologique et de latitude décisionnelle du 'Job Content Questionnaire' de Karasek. *Rev Epidemiol Santé Publique* 1998;46:371-381.
 21. Santé Québec. *Et votre coeur, ça va? Rapport de l'enquête québécoise sur la santé cardiovasculaire*. Québec: Gouvernement du Québec, 1994.
 22. Belkic KL, Landsbergis PA, Schnall PL, Baker D. Is job strain a major source of cardiovascular disease risk? *Scand J Work Environ Health* 2004;30:85-128.
 23. Brisson C, Montreuil S, Punnett L. Effects of an ergonomic training program among video display unit workers. *Scand J Work Environ Health* 1999;25:255-263.
 24. Perreault N, Brisson C, Dionne CE. Agreement between a self-administered questionnaire on musculoskeletal disorders of the neck-shoulder region and a physical examination. *Can J Rehabil* 1998;11:222-223.
 25. Bernard B, Sauter S, Fine L, Petersen M, Hales T. Job task and psychosocial risk factors for work-related musculoskeletal disorders among newspaper employees. *Scand J Work Environ Health* 1994;20:417-426.
 26. Lipscomb J, Trinkoff A, Brady B, Geiger-Brown J. Health care system changes and reported musculoskeletal disorders among registered nurses. *Am J Public Health* 2004;94:1431-1435.
 27. Trinkoff AM, Lipscomb JA, Geiger-Brown J, Storr CL, Brady BA. Perceived physical demands and reported musculoskeletal problems in registered nurses. *Am J Prev Med* 2003;24:270-275.
 28. Skov T, Deddens J, Petersen MR, Endahl L. Prevalence proportion ratios: estimation and hypothesis testing. *Int J Epidemiol* 1998;27:91-95.
 29. Karasek RA, Theorell T, Schwartz JE, Schnall PL, Pieper CF, Michela JL. Job characteristics in relation to the prevalence of myocardial infarction in the US Health Examination Survey (HES) and the Health And Nutrition Examination Survey (HANES). *Am J Public Health* 1988;78:910-918.
 30. Joksimovic L, Starke D, Knesebeck O, Siegrist J. Perceived work stress, overcommitment, and self-reported musculoskeletal pain: a cross-sectional investigation. *Int J Behav Med* 2002;9:122-138.
 31. Daveluy C, Pica L, Audet N, Courtemanche R, Lapointe F. *Enquête sociale et de santé 1998*, 2^e édition. Québec: Institut de la Statistique du Québec, 2000.
 32. Karlqvist L, Tornqvist EW, Hagberg M, Hagman M, Toomingas A. Self-reported working conditions of VDU operators and associations with musculoskeletal symptoms: a cross-sectional study focussing on gender differences. *Int J Ind Ergon* 2002;30:277-294.
 33. Croft PR, Lewis M, Papageorgiou AC *et al.* Risk factors for neck pain: a longitudinal study in the general population. *Pain* 2001;93:317-325.
 34. Demure B, Luippold R, Bigelow C, Ali D, Mundt K, Liese B. Video display terminal workstation improvement program: I. Baseline associations between musculoskeletal discomfort and ergonomic features workstations. *J Occup Environ Med* 2000;42:783-791.
 35. Ortiz-Hernandez L, Tamez-Gonzalez S, Martinez-Alcantara S, Mendez-Ramirez I. Computer use increases the risk of musculoskeletal disorders among newspaper office workers. *Arch Med Res* 2003;34:331-342.
 36. Malchaire J, Cock N, Vergracht S. Review of the factors associated with musculoskeletal problems in epidemiological studies. *Int Arch Occup Environ Health* 2001;74:79-90.
 37. Björkstén M, Boquist B, Talbäck M, Edling C. Reported neck and shoulder problems in female industrial workers: the importance of factors at work and at home. *Int J Ind Ergon* 2001;27:159-170.