Lower limb pain, standing, sitting and walking: the importance of freedom to adjust one's posture.

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Abstract

Prolonged standing at work has been associated with lower extremity discomfort and cardiovascular symptoms. Since standing postures vary as to duration, type and constraint, and prolonged sitting has also been associated with discomfort and cardiovascular effects, associations between specific postures and health symptoms should be explored. Data from the 1998 Quebec Health and Social Survey were analyzed in this study; pain in the lower legs/calves or ankles/feet during the previous 12 months interfering with usual activities fairly often or all the time was the outcome studied. Fully 59% of workers in this study usually stand at work. Women had a significantly greater prevalence of lower leg/calf pain (11.0% vs 8.3%) as well as foot/ ankle pain (8.0% vs 5.1%). In the final model, standing (vs. sitting) postures were associated with pain in both lower legs/calves and ankles/feet. Taken together with other research findings, these results suggest that the effects of specific sitting and standing postures on cartilage, muscle and the cardiovascular system should all be considered when seeking to explain discomfort in the lower limb. They also suggest that freedom to sit at work is important in preventing pain in the lower limbs.

Keywords: standing, sitting, mobility, musculoskeletal disorders, psychological work demands, gender

1. Introduction

In Québec, 59% of the employed population usually works standing [1]. Prolonged standing at work has been associated in epidemiological studies with lower extremity (LE) discomfort [2], varicose veins [3], progression of carotid atherosclerosis [4] and complications of pregnancy [5]. Workplace ergonomic studies have associated prolonged standing with foot pain, diminished pain-pressure threshold over the workday, and changes in the regulation of blood pressure [6, 7]. In the laboratory, prolonged standing has been shown to result in LE swelling and discomfort [8, 9].

It is therefore important to diminish work demands associated with prolonged standing at work. However, prolonged sitting has also been associated with discomfort and cardiovascular effects [10] and the optimal proportion of standing and sitting is not known. Sitting and standing postures vary as to duration and freedom to alternate postures, and standing postures vary as to mobility [1, 12, 13], so that it would be useful to identify exactly which characteristics of prolonged standing are associated with health outcomes. Variables included in the 1998 Quebec Health and Social Survey (QHSS-98), permitted study of the potential associations between specific postures and LE symptoms. Some aspects of mobility and freedom to sit or stand were explored in this population-based health survey, and data on lower leg/calf and ankle/foot pain are presented here. Since both working postures [1] and effects [6, 7] have been

shown to vary by gender and gender is associated with many unassessed exposure factors [14], the analysis was stratified by gender.

2. Methods

2.1. Study design and study sample

The QHSS-98 was a household-based population survey of a weighted random sample of all residents outside institutions and Indian reserves in Quebec, Canada. The technical details of the sampling procedures have been discussed elsewhere [15]. Those eligible to complete the section on work of the questionnaire included all who, at the time of the study, worked full time or part-time at a paid job, for an employer or self-employed, including those on holiday, sick-leave, workers' compensation leave, on strike or lockout. 11 735 respondents met this criterion of remunerated work. Those who did not answer the questions on general working posture (N=469), with less than 12 months of seniority in their current job (N=2386), who worked less than 25 hours per week (N=967), who were pregnant (N=63), who were not aged 18 to 65 years (N=30) or who did not answer the questions concerning lower extremity symptoms during the previous 12 month period (N=50) were excluded from the analyses presented in this paper. The total study sample comprised 7770 subjects, 4540 men and 3230 women.

2.2. Variables and measures

The questions concerning musculoskeletal symptoms were adapted from the standardised Nordic questionnaire [16]. For the present analyses, the case definition for clinically significant pain included subjects who reported significant pain during the past 12 months which interfered with their usual activities "fairly often" or "all the time". They were compared to those who reported no significant pain or occasional pain. The present analyses focus on (1) lower leg/calf pain and (2) ankle/foot pain. In preliminary analyses, the two LE areas were not associated with the same risk factors and therefore are considered separately in subsequent analyses.

General posture was assessed by the question "During your normal work day, do you usually work... – 1) standing? ; 2) sitting?" Two additional questions evaluated the levels of constraint or mobility. Those who worked sitting with the possibility of getting up whenever they wanted to were used as the reference category.

Three other measures of physical work demands were included in the study: handling heavy loads; repetitive hand or arm movements; whole-body vibration. Work-related psychological demands and decision latitude were assessed with the two 9-item indices from the Karasek Job Content Questionnaire (JCQ) previously validated for Québec workers [17]. For these two indices, responses were divided into terciles to allow comparison of low, medium and high decision latitude and psychological job demands exposure groups. Sociodemographic variables included age, sufficiency of family income, number of children and presence of a preschool child. Other personal variables included smoking, leisure time physical activity, body mass index, social support, and psychological distress (14-item Ilfeld Psychiatric Symptoms Index).

2.3. Statistical analyses

All outcome and exposure prevalence estimates presented are weighted estimates. Weights were provided by the Institut de la statistique du Québec to make the sample representative of the population and to correct for nonresponse [5]. Chi-square tests were carried out to assess differences in proportions between men and women for all the potential explanatory variables of the study.

Using logistic regression, bivariate analyses were conducted to obtain the crude odds ratios (OR) of lower leg/calf pain and ankle/foot pain and the *p* value for each variable, separately for women and men. Variables for which at least one response category had a p value < 0.25 were retained for the multivariate analyses. To identify potential colinearity and identify synonymous variables for exclusion, the degree of interrelationship of the various risk factors selected for the multivariable analyses was checked using Spearman's rank correlation coefficients. Multiple logistic regression was used to determine factors associated with pain. A stepwise backward deletion approach was used; independent variables which did not meet a level of significance of 0.01 were removed from the multivariate logistic models one variable at a time, provided that such omission did not alter the estimated odds ratio of other variables in the model by more than 10% nor alter the goodness of fit of the model. The choice of level of significance for retention (0.01) was made after considering the size of the population and the number of variables tested. Only the

final model with the best fit is presented. Statistical analyses were carried out with the SPSS/PC (Statistical Program for Social Sciences for the Personal Computer) package, version 13.0 (SPSS Inc. Chicago, Illinois).

3. Results

3.1 The study population

Overall, women were significantly younger, slimmer and had more preschool children; more men had a total of two or more children. More men than women reported never being physically active, having a lower level of social support and having lower psychological distress. At work, men more often reported lifting heavy loads, being exposed to whole-body vibration and doing repetitive work. As well, men reported higher decision latitude and lower job strain.

3.2 Prevalence of pain

Women reported significantly higher prevalence of pain at both LE sites (Table 1).

Table 1.
Prevalence of significant lower extremity pain experienced over the previous 12 months, 1998 Québec population aged 18 or over, employed at least 25h/week[a]

	Men	Women	Overall
N	4540	3230	7770
Lower legs/calves[‡]	5.1%	8.0%	6.3%
Ankles/ feet[‡]	8.3%	11.0%	9.4%

[a] All estimates are weighted to reflect the population and adjusted for the sampling design.
[‡] $p<.05$, for difference between men and women.

3.3 Associations between pain and working conditions

The final models for associations between LE pain and working conditions are presented in Table 2. For reasons of space, the odds ratios for sociodemographic variables are not shown in the table. Female gender, age over 50 and lower household income were associated with increased risk of pain at both sites. For men, being underweight and having preschool children were also associated with pain at both sites, and obesity was associated with foot/ankle pain. In all models, standing (vs. sitting) postures without freedom to sit at will were significantly associated with pain in both lower legs/calves and ankles/feet. In men, all standing postures were significantly associated with pain in ankles/feet. There was no obvious association of pain with mobility except for a possible stronger association, among men, between foot/ankle pain and a more fixed standing posture.

LE pain was also associated with exposures to repetitive work, lifting heavy weights (women), whole-body vibration (men) and intimidation (men). Few women were exposed to whole-body vibration and this variable was not included in the models for women.

Job strain, as measured by the Job Content Questionnaire, was not retained in the multiple regressions. Some individual scales and questions from the JCQ such as the 3-item Decision Authority sub-scale (for both sexes) and 2-items from the Psychological Demands Scale: "My job requires working very hard" (for men) and "My job requires working very fast" (for women) were very strongly associated with pain in bivariate analyses.

4. Discussion

4.1. Associations between pain and working postures

Prolonged standing is clearly associated with an increase in frequency of LE pain symptoms in this study. These results corroborate earlier reports of discomfort [2, 12].

There was no clear effect of mobility on symptom prevalence. This result is in contradiction to those of Vézina et al [18] who found, in an intervention study of sewing machine operators, that increased mobility following job redesign (a task done in a fixed standing position was redesigned to be done while moving short distances) resulted in a sharp decrease in LE pain symptoms among operators who experienced the job rotation intervention and not among controls. Supermarket checkout staff in another study [19] reported preferring larger checkout stations because the slightly increased mobility resulted in diminished LE pain. It is possible that the clear results obtained with a single posture variation in a single job cannot be obtained when effects of postures are examined across a large population with widely-varying working conditions.

4.2 Associations between pain and other working conditions

Some exposures of interest for the musculoskeletal

and circulatory systems of the lower limb were not assessed, such as kneeling and crouching postures, heat exposure, running, and pressing on foot pedals.

Psychological distress was associated with pain at both sites. It is not possible to ascertain the direction of causation with a cross-sectional study.

Of the JCQ scales, only the Psychological Demands Scale (not the Decision Latitude Scale) was associated with pain in the multivariate analyses. The meaning of this association is not clear, since this scale has several items that measure physical as well as psychological demands (e.g., "work fast", "work hard", "hectic work"), and it is important to clarify these relationships [20]. Future studies should distinguish the physical from the psychological components of job strain by use of subscales or individual items.

4.3. Mechanisms involved in LE symptoms

Mechanisms involved in producing LE symptoms can include effects on muscle tissue, connective tissue and the circulatory system. Laperrière et al. [7] have shown that more walking was associated with an increase in the pain sensitivity of the plantar surface of the foot. However, in two studies [7, 21] more static postures in the workplace were associated with a drop in arm blood pressure, probably due to blood pooling in the lower limb. More static postures were also associated with symptoms of orthostatic intolerance [21].

Thus, high and low mobility postures among standing workers may have quite different effects on musculoskeletal tissues than on the cardiovascular system. Such effects could be more clearly explored in the laboratory or a workplace-based study with a narrower range of concomitant exposures and measurement of circulatory and musculoskeletal outcomes.

4.4. Gender differences in pain prevalence

Even when controlling for other risk factors in the multivariate analysis of the total study sample, female gender was strongly associated with lower extremity pain. A similar residual male-female difference in pain prevalence has been found in other data sets [22]. We do not know whether the gender difference in pain prevalence is attributable to unassessed gender-associated exposures (intrastratum confounding) or to differences in pain experience or reporting [14]. In a population-based study, it cannot be presumed that men and women who report the same postures at work are in fact in similar situations and experience similar postural constraints [23, 24, 25].

4.5 Prevention

Among those who work sitting in Québec, 80% can stand at will whereas among those who work standing, only 19% can sit at will [1]. Ability to sit appears to be associated with older age and higher income [1, 26]. In other countries, prolonged standing at work is much rarer (27). Constrained standing in Québec is attributable to job design but also to employers' perception that customers prefer to be served by standing workers [26]; both of these should be addressed by ergonomists.

4.6. Future studies

The questions used in this survey did not adequately distinguish between freedom to sit and mobility; this should be remedied [13]. Future surveys should also include validated questions on the placement of break times [12]. Also, in this study, the foot was not distinguished from the ankle area and the lower leg was not distinguished from the calf. If it is indeed important to distinguish circulatory and musculoskeletal components of LE pain determination, it may be necessary to refine the descriptions of the body parts involved.

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Table 2. Workplace risk factors associated with significant calf/leg and ankle/foot pain that interfered with usual activities in the previous 12 months: results from the final logistic model, 1998 Quebec working population aged 18 to 65, ≥ 25 hours per week.[a]

	Adjusted OR (99%CI)		
	Men	**Women**	**Total population[b]**
CALF/LEG PAIN			
Working posture			
Sitting with the possibility of getting up at will	1.0	1.0	1.0
Standing with the possibility of sitting down at will	2.18 (1.00-4.78)†	1.52 (0.70-3.32)	1.95 (1.13-3.36) †
Standing and moving around, longer distances	3.60 (1.96-6.62) §	3.31 (1.88-5.82) §	3.61 (2.38-5.47) §
Standing and moving around, short distances	3.79 (1.99-7.26) §	2.39 (1.33-4.27) §	3.13 (2.03-4.83) §
Standing in a fixed or relatively fixed position	3.47 (1.54-7.77) §	3.21 (1.58-6.55) §	3.69 (2.19-6.23) §
Sitting in a constrained posture	1.45 (0.60-3.49)	0.80 (0.32-1.99)	1.22 (0.66-2.25)
Handling heavy loads - Never or occasionally		1.0	1.0
Fairly often		1.74 (0.97-3.14) ‡	1.21 (0.83-1.78)
All the time		2.56 (1.30-5.04) §	1.64 (1.06-2.54) §
Repetitive work - Never or occasionally		1.0	
Fairly often		1.10 (0.56-2.17)	
All the time		1.50 (0.90-2.49) ‡	
Whole body vibration - Never or occasionally	1.0		1.0
Fairly often	1.45 (0.74-2.83)		1.45 (0.76-2.77)
All the time	3.48 (1.92-6.32) §		3.01 (1.68-5.39) §
Intimidation at work - Never	1.0		1.0
Occasionally, often or very often	1.51 (0.98-2.33) ‡		1.38 (1.02-1.88) †
Decision latitude - High		1.0	
Medium		1.39 (0.82-2.36)	
Low		1.37 (0.81-2.30)	
Psychological job demands -Low	1.0	1.0	1.0
Medium	1.24 (0.76-2.03)	1.00 (0.61-1.64)	1.12 (0.79-1.58)
High	1.45 (0.89-2.36) ‡	1.29 (0.79-2.09)	1.32 (0.94-1.86) ‡
Elevated psychological distress	2.43 (1.58-3.73)§	1.97 (1.31-2.96)§	2.14 (1.59-2.87)§
ANKLE/FOOT PAIN			
Working posture			
Sitting with the possibility of getting up at will	1.0	1.0	1.0
Standing with the possibility of sitting down at will	1.88 (0.97-3.63) ‡	1.14 (0.57-2.28)	1.47 (0.92-2.34) ‡
Standing and moving around, longer distances	3.44 (2.11-5.60) §	3.51 (2.18-5.65) §	3.41 (2.46-4.72) §
Standing and moving around, short distances	3.36 (1.98-5.72) §	3.11 (1.95-4.95) §	3.16 (2.23-4.46) §
Standing in a fixed or relatively fixed position	5.19 (2.78-9.69) §	2.82 (1.50-5.28) §	3.89 (2.53-5.99) §
Sitting in a constrained posture	1.44 (0.70-2.96)	0.55 (0.24-1.27)	0.93 (0.55-1.57)
Handling heavy loads - Never or occasionally		1.0	
Fairly often		0.61 (0.33-1.14) ‡	
All the time		1.76 (0.93-3.31) ‡	
Repetitive work - Never or occasionally	1.0	1.0	1.0
Fairly often	1.13 (0.67-1.88)	1.47 (0.85-2.57)	1.24 (0.86-1.81)
All the time	1.37 (0.92-2.05) ‡	1.73 (1.11-2.70) §	1.52 (1.14-2.04) §
Whole body vibration - Never or occasionally	1.0		1.0
Fairly often	1.05 (0.58-1.90)		1.10 (0.63-1.94)
All the time	2.40 (1.40-4.10) §		2.35 (1.41-3.93) §
Intimidation at work - Never	1.0		1.0
Occasionally, often or very often	1.54 (1.08-2.20) †		1.39 (1.08-1.81) §
Psychological job demands -Low	1.0	1.0	1.0
Medium	1.47 (0.99-2.17) ‡	1.25 (0.82-1.91)	1.37 (1.03-1.81) †
High	1.35 (0.91-2.02)	1.62 (1.07-2.45) †	1.45 (1.09-1.93) §
Elevated psychological distress	1.95 (1.35-2.79)§	1.87 (1.31-2.68)§	1.84 (1.42-2.36)§

‡ $p<0.05$, † $p\leq0.01$, § $p\leq0.001$. [a] Controlling for age, BMI and household income [b] Controlling for gender