Distal Lower-Extremity Pain and Work Postures in the Quebec Population

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Objectives. Standing at work has been associated with discomfort and cardiovascular symptoms. Because standing postures vary in duration, mobility, and constraint, we explored associations between specific postures and pain in the lower extremities.

Methods. We used multiple logistic regression to analyze associations between work factors and pain in the lower extremities during the previous 12 months that interfered with usual activities. We used data from among 7757 workers who were interviewed in the 1998 Quebec Health and Social Survey.

Results. Among all respondents, 9.4% reported significant ankle or foot pain, and 6.4% had lower-leg or calf pain. Significantly more women than men had pain at both sites. Both leg or calf and ankle or foot pain were strongly associated with standing postures, whole-body vibration, psychological distress, female gender, and being aged 50 years or older. Constrained standing postures were associated with increased ankle or foot pain for both men and women and with leg or calf pain for women, compared with standing with freedom to sit at will.

Conclusions. Freedom to sit at work may prevent lower-extremity pain. The effects of specific sitting and standing postures on cartilage, muscle, and the cardiovascular system may help explain discomfort in the lower extremities. (*Am J Public Health.* 2008;98:705–713. doi:10.2105/AJPH.2006.099317)

In Quebec, 59% of employed persons usually stand while working.[1] Epidemiological studies have associated prolonged standing at work with lower-extremity pain or discomfort, swelling, venous disorders, progression of carotid atherosclerosis, and pregnancy complications.[2–9] In the laboratory, prolonged standing has been shown to result in lower-extremity swelling and discomfort.[10–12] However, prolonged sitting has also been associated with swelling of the lower extremities, discomfort, venous disorders, and vascular effects.[9,13–16] The optimal proportion of standing to sitting is unknown.

Freedom to alternate sitting with standing also varies, as does mobility while standing.[1,17,18] These posture variations have biomechanical and physiological implications. It is therefore important to characterize exposures more precisely to identify exactly which type of posture is associated with which health outcome.

To our knowledge, despite the considerable public health importance of lower-extremity musculoskeletal and vascular disorders[19] and the known relationship between prolonged standing and lower-extremity pain,[3] there has been no population-based research on the contribution of different types of working postures to this pain. The 1998 Quebec Health and Social Survey, a provincewide household survey, offered an opportunity to investigate the prevalence, in the general working population of Quebec, of reported lower-extremity pain and the associations of lower-leg or calf, and ankle or foot pain with working postures and other working conditions.

METHODS

Study Design and Population

Data were taken from the 1998 Quebec Health and Social Survey, a household-based population survey of a weighted random sample of all residents living outside institutions and Indian reserves in Quebec, Canada. The survey used a 2-stage cluster-sampling plan stratified by region.[20] Two instruments were used: an interviewer-administered questionnaire completed by a member of each household aged 18 years or older for each member of the household and a self-administered questionnaire completed by each member of the household aged 15 years or older.

In all, 30 386 individuals were sampled using the interviewer-administered questionnaire (weighted response rate 82%), and 20 773 respondents completed the self-administered questionnaire (a weighted proportion of 84%). The overall self-administered questionnaire weighted response rate was 69%. There were 11 735 respondents to the self-administered questionnaire who, at the time of the study, worked full time or part time at a paid job for an employer or who were self-employed. Those who did not answer the questions on general working postures or lower-extremity symptoms, had less than 12 months of seniority at their current job, worked less than 25 hours per week, were pregnant, or were not aged 18 to 65 years were excluded from the following analyses. The resulting sample for this study comprised 4534 men and 3223 women.

Variables and Measures

The questions concerning musculoskeletal symptoms were adapted from the standardized Nordic questionnaire.[21] Respondents were presented a map with 11 body sites and asked, "In the past 12 months, have you had any significant pain in any of the following body sites which interfered with your usual activities? (never, occasionally, fairly often, all the time)." The case definition for pain included respondents who reported significant pain in a lower-extremity site during the past 12 months that interfered with their usual activities "fairly often" or "all the time."

General work posture was assessed by the question, "During your normal work day, do you usually work (1) standing up? (2) sitting down?" Respondents who reported that they usually stood at work were asked, "Which of the following best describes your posture *most of the time*: (1) Standing in a fixed position with no possibility of moving around; (2) Standing in a relatively fixed position, with the possibility of making one or two steps; (3) Standing and moving around a little bit (for example, from one machine or desk to another); (4) Standing and moving around a bit more (for example, from one office or building to another); (5) Standing, with the possibility of sitting down whenever you want to." Respondents who reported that they usually sat were asked, "Which of the following best describes your posture most of the time: (1) Sitting in a fixed position with no possibility of getting up and moving around; (2) Sitting, with the possibility of getting up once in a while; (3) Sitting, with the possibility of getting up whenever I want to." Because of small numbers, response categories 1 and 2 were combined for both questions. In our analyses, those who sat with the possibility of getting up at will at work were the reference category.

Three other measures of physical work demands were included in this study: handling heavy loads, repetitive hand and arm movements, and exposure to whole-body vibration.

Work-related psychological demands and decision latitude were assessed with two 9-item indexes from the Karasek Job Content Questionnaire,[22] previously validated for Quebec workers.[23,24] For these 2 indexes, respondents were classified according to the median score observed in the 1990 Quebec Cardiovascular Health Survey[25] as low (vs high) decision latitude and low (vs high) psychological job demands. Workers exposed to both high psychological job demands and low decision latitude were defined as the high-strain group; workers not exposed to either job constraint composed the low-strain group. Four additional workplace psychosocial constraints were examined: physical violence, intimidation, unwanted sexual attention, and difficult or tense situations with the public.[26,27]

The household income indicator was calculated using the ratio of household income to the poverty threshold income established by Statistics Canada for household size. Body mass index (BMI; weight in kilograms divided by height in meters squared) was categorized as (1) underweight (<20 kg/m^2), (2) healthy (20–26.9 kg/m^2), (3) overweight (27–29.9 kg/m^2), and (4) obese (≥30 kg/m^2).

The 14-item version of the Ilfeld Psychiatric Symptoms Index[28] assessed psychological distress. The level representing the least distressed 80% of the Quebec population in 1987 was used as a reference category.[29] The Social Support Index[30] included 11 items on social participation, satisfaction with social relations, and size of support network.[31] The lowest quintile was considered to have low social support.

Statistical Analyses

All outcome and exposure prevalence estimates presented were weighted by the Institut de la statistique du Québec to make the sample representative of the population and to correct for nonresponse.[20] Analyses were stratified by gender because gender has been shown to be associated with exposures at work.[1,32]

We used logistic regression to conduct bivariate analyses and obtain the crude odds ratios (ORs) of lower-leg or calf pain, and ankle or foot pain, as well as the corresponding *P* value for each exposure variable. Variables for which at least 1 response category had a *P* value less than .25 were retained for the multivariate analyses, with the exception of age, BMI, and job strain, which were included a priori as potential confounding factors. Potential collinearity was verified using a Spearman's rank correlation matrix of risk factors selected for multivariate analyses. Multiple logistic regression was then used to determine factors associated with pain separately at the 2 sites. A stepwise backward deletion approach was used; independent variables that did not meet a level of significance of .01 were removed from the multivariate logistic models 1 variable at a time, provided that such omission did not alter the estimated OR of other variables in the model by more than 10% or alter the goodness of fit of the model. The fairly rigorous choice of level of significance for retention was made after considering the study design and the number of variables tested, following the suggestion of the Quebec Health and Social Survey statisticians. Each model was tested with the Hosmer–Lemeshow goodness-of-fit test.[33] Only the final model with the best fit is presented. Statistical analyses were done using SPSS, version 13.0 (SPSS Inc, Chicago, Ill).

TABLE 1—Prevalence of Significant Lower-Extremity Pain Among the Working Population Aged 18 to 65 Years: Quebec, 1998

Pain	Men, %	Women, %	Total, %
Whole sample			
Lower legs or calves*	5.1	8.0	6.3
Ankles or feet*	8.3	11.0	9.4
Knees*	9.6	7.2	8.6
Hips or thighs	4.2	6.0	5.0
Standing population			
Lower legs or calves**	6.9	12.6	8.8
Ankles or feet**	10.8	17.1	13.0
Knees	11.3	9.3	10.6
Hips or thighs	4.8	7.4	5.7
Sitting population			
Lower legs or calves	2.5	3.8	3.1
Ankles or feet	4.2	5.4	4.8
Knees	6.9	5.2	6.1
Hips or thighs	3.3	4.8	4.0

Note. All estimates were weighted to reflect the population and were adjusted for the sampling design. Pain was defined as interfering with usual activities fairly often or all the time over the previous 12 months. Survey respondents worked 25 hours per week or more.
*$P<.05$; **$P<.01$, for difference between men and women.

RESULTS

Prevalence of Lower-Extremity Symptoms

Female workers reported a significantly higher prevalence of lower-extremity pain than did men (Table 1). There were also gender differences in personal characteristics among respondents: women tended to be younger and reported being significantly slimmer and having more preschool children than did men; men tended to have more children and reported a significantly lower level of social support, a lower level of psychological distress, and a lower proportion of leisure-time physical activity compared with women.

Table 2 presents the prevalence of workplace exposure variables and the results of the bivariate analyses for associations between exposure variables and distal lower-extremity pain. A significantly larger proportion of men

TABLE 2—Prevalence of Occupational Factors and Odds Ratios of Lower-Leg or Calf Pain and Ankle or Foot Pain in Bivariate Logistic Regression Analyses Among the Working Population Aged 18 to 65 Years: Quebec, 1998

	Men	Women	Lower-Leg or Calf Pain				Ankle or Foot Pain			
	(n = 4534), %	(n = 3223), %	Men OR	*P*	Women OR	*P*	Men OR	*P*	Women OR	*P*
Detailed working posture										
Sitting with the possibility of getting up at will**	30.7	43.0	1.0		1.0		1.0		1.0	
Standing with the possibility of sitting down at will	10.6	9.3	3.21	<.001	1.63	.088	2.07	.002	1.28	.344
Moving around, long distances[a] **	27.1	15.0	4.09	<.001	5.17	<.001	3.69	<.001	4.37	<.001
Moving around, short distances[b]	16.5	16.3	4.19	<.001	2.99	<.001	3.65	<.001	3.52	<.001
Standing in a fixed or relatively fixed position[c]	6.6	6.6	4.37	<.001	4.86	<.001	6.38	<.001	3.98	<.001
Sitting in a constrained posture[d]	8.6	9.8	2.82	.001	1.03	.929	2.36	<.001	0.80	.460
Usual posture**										
Sitting	38.7	52.3	1.0		1.0		1.0		1.0	
Standing	61.3	47.7	2.85	<.001	3.72	<.001	2.81	<.001	3.61	<.001
Handling heavy loads										
Never or occasionally**	76.9	89.5	1.0		1.0		1.0		1.0	
Fairly often**	14.8	6.9	1.59	.008	3.25	<.001	1.74	<.001	1.30	.222
All the time**	8.3	3.6	2.65	<.001	6.36	<.001	2.40	<.001	4.26	<.001
Repetitive hand and arm movements										
Never or occasionally	79.9	79.3	1.0		1.0		1.0		1.0	
Fairly often	7.9	7.5	1.94	.002	1.44	.127	1.77	.002	1.81	.002
All the time	12.2	13.2	2.36	<.001	2.34	<.001	2.75	<.001	2.24	<.001
Whole-body vibrations										
Never or occasionally**	89.6	99.3	1.0		NA[e]		1.0		NA[e]	
Fairly often	5.4	0.4	1.81	.016	...		1.51	.050	...	
All the time	5.0	0.3	3.49	<.001	...		2.55	<.001	...	
Difficult or tense situations with public										
Never, rarely, occasionally, no contact with public	73.9	69.9	1.0		1.0		1.0		1.0	
Often or very often	26.0	30.1	1.46	.008	1.80	<.001	1.11	.384	1.48	.001
Physical violence at work										
Never	97.3	96.6	1.0		1.0		1.0		1.0	
Occasionally, often, or very often	2.7	3.4	2.16	.010	2.09	.008	0.89	.730	1.42	.209
Intimidation at work										
Never	82.7	80.5	1.0		1.0		1.0		1.0	
Occasionally, often, or very often	17.3	19.5	1.92	<.001	1.69	<.001	1.93	<.001	1.72	<.001
Unwanted sexual attention at work **										
Never	98.4	92.5	1.0		1.0		1.0		1.0	
Occasionally, often, or very often	1.6	7.5	0.98	.972	1.57	.040	0.80	.637	1.69	.005
Decision latitude**										
High	50.2	39.2	1.0		1.0		1.0		1.0	
Low	49.8	60.8	1.11	.427	1.49	.006	1.41	.001	1.20	.128
High psychological job demands										
Low	51.0	52.5	1.0		1.0		1.0		1.0	
High	49.0	47.5	1.29	.059	1.49	.003	1.18	.130	1.51	<.001
Job strain										
Low strain[f]	21.5	18.2	1.0		1.0		1.0		1.0	
Passive[g] *	29.5	34.3	0.77	.185	1.04	.842	1.49	.015	0.91	.593
Active[h] **	28.8	21.1	0.90	.571	0.96	.869	1.27	.163	1.07	.734
High strain[i] **	20.2	26.4	1.43	.063	2.01	.001	1.86	<.001	1.71	.002

Continued

TABLE 2—*Continued*

Length of work week, h										
25–35	13.7	44.8	1.0	1.0	1.0	1.0				
36–40	52.6	44.1	1.65	.035	1.20	.190	1.85	.001	1.08	.516)
>40	33.7	11.1	1.69	.032	1.03	.902	1.56	.028	1.05	.794)

Note. OR = odds ratio. Pain was defined as interfering with usual activities fairly often or all the time over the previous 12 months. Survey respondents worked 25 hours per week or more. All estimates were weighted to reflect the population and adjusted for the sampling design.
[a]Standing and moving around a fair amount (e.g., from 1 office or building to another).
[b]Standing and moving around a little bit (e.g., from 1 machine or desk to another).
[c]Standing in a fixed position with no ability to move around or in a relatively fixed position, with the ability to make 1 or 2 steps.
[d]Sitting in a fixed position with no possibility of getting up and moving around or with the possibility of getting up once in a while.
[e]Sample size too small for multivariate analyses or too few women exposed.
[f]Low psychological demands, high decision latitude.
[g]Low psychological demands, low decision latitude.
[h]High psychological demands, high decision latitude.
[i]High psychological demands, low decision latitude.
**P* < .05; ***P* < .01, for differences between men and women.

usually stood at work (61.3% vs 47.7%) than of women. Men also reported more frequent exposure to lifting heavy loads, whole-body vibration, and longer work weeks than did women.

Lower-leg and calf pain was highly associated (OR>2) in both men and women with standing postures, handling heavy loads, repetitive hand and arm movements, physical violence at work, and high job strain, and, in men only, whole-body vibration. Ankle or foot pain was highly associated in both men and women with standing postures, handling heavy loads, repetitive hand and arm movements, and, in men only, whole-body vibration.

Factors Associated With Lower-Extremity Pain in Multivariate Models

The final multiple logistic regression models for associations between risk factors and pain at each of the 2 body sites are presented in Tables 3 and 4. In the total population model, lower-leg and calf pain was strongly associated with female gender, age 50 years or older, absence of leisure physical activity, standing postures, whole-body vibration, psychological distress, and to a lesser extent, handling heavy loads. Ankle or foot pain in the total population model was similarly associated with female gender, age 50 years or older, standing postures, whole-body vibration, and psychological distress. It was also associated with high BMI, low household income, intimidation at work, and repetitive hand and arm movements.

In all models, standing most of the time without freedom to sit at will was significantly associated with pain, irrespective of mobility. For those who were not free to sit at will, the risk for distal lower-extremity pain was approximately the same irrespective of mobility. The main exception was the association between ankle or foot pain and a more fixed standing posture among men.

Similar multiple logistic regression analyses (data not shown) were conducted with the same variables, but standing with freedom to sit became the reference group and all other categories of standing were combined. For men, the OR of leg or calf pain for other categories of standing compared with standing with freedom to sit for men was 1.75 (95% confidence interval [CI]=0.94, 3.29) and for women, 2.87 (95% CI=1.86, 4.43). The OR of ankle or foot pain for other standing postures compared with standing with freedom to sit was 3.04 (95% CI=2.08, 4.44) for men and 3.08 (95% CI=2.15, 4.43) for women.

Lifting heavy loads was associated with distal lower-extremity pain among women. Repetitive hand and arm movements were significantly associated with ankle or foot pain for women, and this association approached $P<.01$ in the ankle or foot pain model for men ($P=.027$); 46% of the men and 44% of the women who remained most of the time in a fixed standing posture at work were also doing repetitive hand and arm movements at work all the time.

Exposure to whole-body vibration all the time was strongly associated with distal lower-extremity pain for men and the total population. Few women were exposed to whole-body vibration, and this variable could not be included in the analyses for women.

Although a tendency for high job strain to be associated with distal lower-extremity pain was present in the bivariate analysis, the associations in the final models were not significant. Distal lower-extremity pain was associated with intimidation at work for men only.

DISCUSSION

The major finding of this study is that standing at work without freedom to sit down at will is strongly associated with pain in the lower leg or calf, and the ankle or foot for both men and women. This finding has not previously been reported in a population-based study with adjustment for other workplace and personal factors, although it is supported by laboratory studies that show lower-extremity pain associated with constrained standing.[10,12,17] The association of ankle or foot, and leg or calf pain with heavy lifting among women is also new; the few epidemiological studies examining lower-extremity musculoskeletal disorders and occupational factors primarily concerned hip and knee pain.[19] Also, the contribution of psychological distress and workplace psychological factors, such as intimidation, to these types of distal lower-extremity pain has not been shown previously.

A large proportion of Quebec workers reported significant lower-extremity pain

TABLE 3—Risk Factors Associated With Significant Lower-Leg or Calf Pain Among the Working Population Aged 18 to 65 Years: Quebec, 1998

	Men,[a] AOR (99% CI)	Women,[a] AOR (99% CI)	Total Population,[a] AOR (99% CI)
Gender			
Men			1.00
Women			2.72*** (1.87, 3.95)
Age, y			
25–39 (Ref)	1.00	1.00	1.00
18–24	0.59 (0.22, 1.62)	1.30 (0.59, 2.83)	0.91 (0.50, 1.67)
40–49	1.43 (0.88, 2.32)	1.78*** (1.12, 2.84)	1.56** (1.11, 2.21)
50–65	2.19*** (1.28, 3.75)	2.96*** (1.78, 4.91)	2.45***(1.67, 3.59)
Household income			
Upper-middle- or higher-income quintiles (Ref)		1.00	1.00
Very poor, poor, or lower-middle-income quintiles		1.51** (1.02, 2.23)	1.31[b] (0.99, 1.72)
Having a preschool child			
No (Ref)	1.00		1.00
Yes	1.88*** (1.15, 3.08)		1.86** (1.17, 2.96)
Having a preschool child by gender (interaction)			0.38** (0.18, 0.81)
BMI, kg/m^2			
Healthy weight (20–26.9; Ref)	1.00	1.00	1.00
Underweight (< 20)	3.04*** (1.46, 6.33)	0.95 (0.53, 1.72)	2.71*** (1.32, 5.60)
Overweight (27–29.9)	1.02 (0.64, 1.62)	0.69 (0.33, 1.43)	1.06 (0.67, 1.69)
Obese (≥ 30)	1.38 (0.80, 2.38)	1.11 (0.63, 1.96)	1.41 (0.82, 2.42)
BMI, kg/m^2 by gender (interaction)			
Underweight (< 20) by female			0.38** (0.15, 0.95)
Overweight (27–29.9) by female			0.65 (0.27, 1.53)
Obese (≥ 30) by female			0.77 (0.36, 1.69)
Leisure physical activities, > 20 min at a time			
Once a week or more (Ref)	1.00		1.00
Once, twice, or 3 times a month	1.11 (0.65, 1.89)		1.08 (0.76, 1.54)
Never	1.79*** (1.18, 2.73)		1.47** (1.09, 2.00)
Detailed working posture			
Sitting with the possibility of getting up at will (Ref)	1.00	1.00	1.00
Standing with the possibility of sitting down at will	2.11* (0.97, 4.61)	1.45 (0.67, 3.14)	1.80** (1.04, 3.11)
Moving around, long distance	3.64*** (1.97, 6.71)	3.39*** (1.93, 5.95)	3.56*** (2.34, 5.40)
Moving around, short distance	3.91*** (2.03, 7.54)	2.49*** (1.41, 4.41)	3.05*** (1.97, 4.70)
Standing in a fixed position	3.46*** (1.52, 7.89)	3.64*** (1.84, 7.20)	3.60*** (2.12, 6.09)
Sitting in a constrained posture	1.46 (0.60, 3.55)	0.87 (0.35, 2.13)	1.20 (0.65, 2.22)
Handling heavy loads			
Never or occasionally (Ref)		1.00	1.00
Fairly often		1.83** (1.02, 3.26)	1.23 (0.84, 1.81)
All the time		2.78*** (1.44, 5.39)	1.62** (1.04, 2.53)
Whole body vibrations			
Never or occasionally (Ref)	1.00		1.00
Fairly often	1.44 (0.73, 2.82)		1.32 (0.69, 2.55)
All the time	3.70*** (2.02, 6.76)		2.98*** (1.65, 5.38)

Continued

(Table 1). Our results are difficult to compare with those obtained in other surveys, because of differences in the exact pain locations included, case definitions, and the populations studied.[19] A review of lower-extremity musculoskeletal and vascular disorders and symptoms suggested that the prevalence of pain in working populations can reach 83% for foot or ankle pain and 20% for lower-leg pain.[19]

Associations Between Pain and Working Postures and the Mechanisms Involved

Prolonged standing is clearly associated with an increase in frequency of distal lower-extremity pain symptoms in this study, an association that could be mediated by mechanisms involving the cardiovascular system, muscle tissue, or connective tissue. Standing is a known risk factor for venous disorders,[5–7] probably caused by blood pooling in the lower extremities; other effects on the cardiovascular system have also been reported.[8] Effects on muscles in the lower limb are less well documented; it is known that muscle fatigue can be induced by static contraction[34] but also by prolonged walking.[35] The effects of standing on lower-extremity connective tissue have not been demonstrated.[36]

There was no clear effect of mobility on distal lower-extremity pain prevalence. This result is in contradiction to those of Vézina et al.,[37] who found, in an intervention study of sewing machine operators, that increased mobility following job redesign resulted in a sharp decrease in lower-extremity pain symptoms among operators who experienced the redesign and not among controls. It is possible that the clear results obtained with a specific intervention in one workplace cannot be obtained when effects of postures are examined across a large population with widely varying working conditions. Also, as suggested by small-scale ergonomic studies, mobility may increase the likelihood of pain in muscle tissue by mechanisms such as overexertion and impact but decrease the likelihood of pain in other lower-extremity tissues by other mechanisms affecting the vascular system.[36,38] Mobility may therefore have different effects on the musculoskeletal and cardiovascular systems of standing workers. Such effects could be more clearly explored in the laboratory or in a workplace-based

TABLE 3—*Continued*

Intimidation at work			
Never (Ref)	1.00		1.00
Occasionally, often, or very often	1.55** (1.00, 2.39)		1.43** (1.05, 1.94)
Job strain			
Low strain[c] (Ref)	1.00	1.00	1.00
Passive[d]	0.51** (0.30, 0.89)	0.89 (0.49, 1.61)	0.71* (0.47, 1.06)
Active[e]	0.74 (0.43, 1.27)	0.77 (0.39, 1.51)	0.79 (0.52, 1.21)
High strain[f]	0.92 (0.54, 1.58)	1.43 (0.80, 2.54)	1.11 (0.75, 1.66)
Elevated psychological distress	2.48*** (1.61, 3.81)	1.95*** (1.30, 2.94)	2.17*** (1.61, 2.92)

Note. AOR = adjusted odds ratio; CI = confidence interval; BMI = body mass index. BMI was measured as weight in kilograms divided by height in meters squared. Data reported are the results of the final logistic regression models. Pain was defined as interfering with usual activities fairly often or all the time over the previous 12 months. Survey respondents worked 25 hours per week or more.

[a]Hosmer–Lemeshow goodness-of-fit test: $P = .820$ for the model for men; $P = .118$ for the model for women; $P = .234$ for the model for the total population.

[b]$P = .013$.

[c]Low psychological demands, high decision latitude.

[d]Low psychological demands, low decision latitude.

[e]High psychological demands, high decision latitude.

[f]High psychological demands, low decision latitude.

*$P < .05$; **$P < .01$; ***$P < .001$.

study with a narrower range of concomitant exposures and simultaneous measurement of circulatory and musculoskeletal outcomes.

It is also possible that the questions used in the Quebec Health Survey did not adequately measure mobility, although very similar questions on mobility have been validated in a sample of 45 Quebec industrial and service workers.[18]

Associations Between Pain and Workplace Conditions

Repetitive hand and arm movements were significantly associated with ankle or foot pain among women. In a study in Lithuania, repetitive finger movements were also associated with leg pain.[39] This result may be attributable to the presence of constraints that are commonly found on assembly lines together with repetitive work but that were not assessed by the questionnaire, such as externally controlled work speed and infrequent breaks. These latter, associated conditions may result in a greater number of constrained postures.

Handling heavy loads was significantly associated with distal lower-extremity pain among women. Some studies suggest an association between heavy lifting and knee or hip pain,[40,41] but no previous study found associations with pain at other lower-extremity sites. Sobaszek et al. showed that jobs involving prolonged standing and handling of heavy loads may aggravate venous disorders.[42] The association between distal lower-extremity pain and heavy lifting among men was not retained in the multivariate analysis once other risk factors were taken into account. This may be attributable to a gender difference or to different conditions of heavy lifting among men and women; for example, many of the women who did heavy lifting worked in health care, which was not true for men.

Whole-body vibration was strongly associated with lower-extremity pain among men (few women were exposed). Whole-body vibration has previously been associated with hip pain[43] and venous disorders.[42]

Although significant associations were observed between high job strain and lower-extremity pain in the bivariate analyses, they were no longer significant after we controlled for the physical demands of work in the multivariate analysis. It is possible that the psychological demand scale acted as a measure of both physical and psychological demands of work, because the scale includes items that can be interpreted as measuring either physical or psychological demands (e.g., “work fast,” “work hard,” “hectic work”).[44]

The associations observed between exposure to intimidation at work and lower-extremity pain persisted for men in the logistic regression. Psychological distress was also associated with lower-extremity pain in both genders. Although the direction of causality is not known in this cross-sectional study, psychological distress and depression have been found to predict musculoskeletal morbidity at various lower-extremity locations.[45,46] Psychological stressors may induce muscle tension and may influence biomechanical loads through changes in posture, movements, and exerted forces.[45,47–49]

Associations Between Pain and Nonoccupational Factors

In our study, older age was associated with lower-extremity pain among both women and men.[50] In a general working population, age has been found to be a risk factor for ankle pain in both genders[51] and is associated with a higher prevalence of venous disorders.[5,52] Among men, obesity was significantly associated with ankle or foot pain and underweight with lower-leg or calf pain. It is noteworthy that high BMI was not associated with distal lower-extremity pain among women nor with lower-leg or calf pain among men. Other studies have found links between overweight and foot[50] or ankle[50,53] pain among men and women. In our study, we could not distinguish between ankle and foot pain. There is evidence that greater body mass is related to increased risk of varicose veins, particularly among women.[54–57] The direction of the relationship between standing, obesity, and pain could not be explored in any of these cross-sectional studies, including ours.

Not exercising was associated with lower-leg or calf pain among men, but no association was found among women. No previous study specifically looked at the relationship of foot or lower-leg pain to leisure-time physical activity, although it has been reported that persons with venous disorders had lower levels of physical activity than did others.[57] Our study was cross-sectional, and it is possible that workers with pain may diminish their activity level.

Female gender was strongly associated with lower-extremity pain in the multivariate analyses, as has been found in other data sets.[58,59] We do not know whether the residual gender difference in pain prevalence is attributable to

TABLE 4—Risk Factors Associated With Significant Ankle or Foot Pain Among the Working Population Aged 18 to 65 Years: Quebec, 1998

	Men,[a] AOR (99% CI)	Women,[a] AOR (99% CI)	Total Population,[a] AOR (99% CI)
Gender			
Men (Ref)			1.00
Women			2.39*** (1.76, 3.25)
Age, y			
25–39 (Ref)	1.00	1.00	1.00
18–24	1.40 (0.78, 2.52)	1.79* (0.96, 3.34)	1.47* (0.96, 2.26)
40–49	1.09 (0.74, 1.59)	1.10 (0.73, 1.65)	1.07 (0.81, 1.42)
50–65	1.41* (0.91, 2.19)	2.61*** (1.72, 3.97)	1.86*** (1.36, 2.53)
Household income			
Upper-middle- or higher-income quintiles (Ref)	1.00	1.00	1.00
Very poor, poor, or lower-middle-income quintiles	1.44** (1.06, 1.95)	1.39 (0.99, 2.23)[b]	1.39*** (1.11, 1.75)
Having a preschool child			
No (Ref)	1.00		1.00
Yes	1.69*** (1.14, 2.50)		1.81*** (1.25, 2.63)
Having a preschool child by gender (interaction)			0.38*** (0.20, 0.70)
BMI, kg/m^2			
Healthy weight (20–26.9; Ref)	1.00	1.00	1.00
Underweight (< 20)	1.87* (0.96, 3.63)	0.65* (0.37, 1.14)	1.91[b] (0.99, 3.71)
Overweight (27–29.9)	1.17 (0.80, 1.70)	1.33 (0.79, 2.25)	1.16 (0.80, 1.70)
Obese (≥ 30)	2.22*** (1.48, 3.33)	1.25 (0.76, 2.04)	2.23*** (1.48, 3.35)
BMI, kg/m^2 by gender (interaction)			
Underweight (< 20) by female			0.34** (0.14, 0.80)
Overweight (27–29.9) by female			1.12 (0.59, 2.13)
Obese (≥ 30) by female			0.54[b] (0.28, 1.01)
Detailed working posture			
Sitting with the possibility of getting up at will (Ref)	1.00	1.00	1.00
Standing with the possibility of sitting down at will	1.90* (0.99, 3.65)	1.07 (0.54, 2.12)	1.38 (0.87, 2.21)
Moving around, longer distance	3.66*** (2.25, 5.96)	3.47*** (2.15, 5.58)	3.44*** (2.48, 4.77)
Moving around, short distance	3.59*** (2.11, 6.10)	3.01*** (1.89, 4.78)	3.16*** (2.23, 4.47)
Standing in a fixed position	6.29*** (3.46, 11.5)	2.78*** (1.49, 5.21)	3.95*** (2.56, 6.10)
Sitting in a constrained posture	1.48 (0.72, 3.04)	0.55 (0.24, 1.27)	0.92 (0.54, 1.56)
Handling heavy loads			
Never or occasionally (Ref)		1.00	
Fairly often		0.64 (0.34, 1.19)	
All the time		1.79* (0.95, 3.38)	
Repetitive hand and arm movements			
Never or occasionally (Ref)		1.00	1.00
Fairly often		1.49 (0.85, 2.60)	1.27 (0.87, 1.85)
All the time		1.70** (1.08, 2.66)	1.53*** (1.14, 2.07)
Whole body vibrations			
Never or occasionally (Ref)	1.00		1.00
Fairly often	1.08 (0.60, 1.94)		1.00 (0.57, 1.78)
All the time	2.67*** (1.58, 4.52)		2.40*** (1.43, 4.03)

Continued

unassessed gender-associated exposures, to intrastratum confounding, to non–work-related gender differences, or to gender differences in pain prevalence or pain reporting.[32,60] In a population-based study, it cannot be presumed that men and women who report the same postures at work are, in fact, exposed to similar working conditions and experience similar postural constraints.[61–63] Residual confounding is always possible, because we did not have information on every potential confounder, such as heat exposure, pressing on foot pedals, type of floor, previous lower-extremity injury, and perhaps notably, type of footwear. Such confounding would have weakened the observed relationships.

Implications for Prevention

Among those who work sitting in Quebec, 80% can stand at will. Among those who work standing, only 19% can sit at will.[1] Ability to sit at will appears to be associated with older age and higher income.[1] Almost 60% of Quebec workers usually stand at work, a proportion much higher than in Europe[64] and elsewhere outside North America. Redesign of many jobs performed in a standing position in North America would likely reduce the health problems associated with standing at work.

Employers in Quebec and possibly elsewhere in North America may require constrained standing of service-sector employees because of their perception that standing workers appear to customers to be more diligent than do sitting workers[65]; job redesign should take these concerns into account.

It is still not known with precision whether the different types of mobility and of constrained postures influence the strength of association between distal lower-extremity pain and standing. Biomechanical and physiological studies with valid, reliable measures of exposures and outcomes are likely to help us understand these relationships. Their results may also help us formulate better questions for population surveys.

Many of the uncertainties in our results could be addressed by a prospective study. In such a study, some methodological adjustments would be desirable. The exposure measures for standing postures should more adequately distinguish between freedom to sit at will and mobility.[18] Future surveys

TABLE 4—*Continued*

Intimidation at work			
Never (Ref)	1.00		1.00
Occasionally, often, or very often	1.57*** (1.10, 2.23)		1.45*** (1.12, 1.87)
Job strain			
Low strain[c] (Ref)	1.00	1.00	1.00
Passive[d]	1.02 (0.65, 1.60)	0.68* (0.41, 1.11)	0.84 (0.60, 1.18)
Active[e]	1.18 (0.74, 1.88)	0.99 (0.58, 1.68)	1.07 (0.75, 1.52)
High strain[f]	1.07 (0.67, 1.73)	1.21 (0.74, 1.98)	1.13 (0.80, 1.59)
Elevated psychological distress	2.00*** (1.39, 2.86)	1.85*** (1.29, 2.66)	1.87*** (1.45, 2.41)

Note. AOR = adjusted odds ratio; CI = confidence interval; BMI = body mass index. BMI was measured as weight in kilograms divided by height in meters squared. Data reported are the results of the final logistic regression models. Pain was defined as interfering with usual activities fairly often or all the time over the previous 12 months. Survey respondents worked 25 hours per week or more.
[a]Hosmer–Lemeshow goodness-of-fit test: $P = .260$ for the model for men; $P = .500$ for the model for women; $P = .191$ for the model for the total population.
[b]$P = .012$.
[c]Low psychological demands, high decision latitude.
[d]Low psychological demands, low decision latitude.
[e]High psychological demands, high decision latitude.
[f]High psychological demands, low decision latitude.
*$P < .05$; **$P < .01$; ***$P < .001$.

should also include validated questions on the placement and length of break times.[9,17] Also, in this study, the foot was not distinguished from the ankle and the lower leg was not distinguished from the calf. If it is indeed important to distinguish circulatory and musculoskeletal components of lower-extremity pain, it would be useful to give precise descriptions of the body parts involved and to assess relevant comorbid medical conditions. Future studies should explore relationships between physical and psychological components of job strain and distinguish between them.[44,66] We suggest studying the relationship between specific lower-extremity disorders and clearly defined observed postures in prospective epidemiological studies of specific working populations to explore the relationships observed in this cross-sectional study. ■

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Contributors

K. Messing originated the study and supervised all aspects of its implementation. F. Tissot carried out all the analyses and wrote the first draft of the article. S. Stock was responsible for the design and overall analysis of the 1998 Quebec Health and Social Survey questions concerning musculoskeletal disorders. All authors helped to originate the design and methods, interpret findings, and revise drafts of the article.

Human Participant Protection

The protocol for this health survey was approved by the ethics committee of Santé Québec.

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