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Should studies of risk factors for musculoskeletal disorders be stratified by gender? Lessons from the 1998 Québec Health and Social Survey

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Corrections

See 2009;35(5):400 for a correction.

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Should studies of risk factors for musculoskeletal disorders be stratified by gender? Lessons from the 1998 Québec Health and Social Survey

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Messing K, Stock SR, Tissot F. Should studies of risk factors for musculoskeletal disorders be stratified by gender? Lessons from the 1998 Québec Health and Social Survey. *Scand J Work Environ Health.* 2009;35(2):96–112.

Objectives Several studies have reported male-female differences in the prevalence of symptoms of work-related musculoskeletal disorders (MSD), some arising from workplace exposure differences. The objective of this paper was to compare two strategies analyzing a single dataset for the relationships between risk factors and MSD in a population-based sample with a wide range of exposures.

Methods The 1998 Québec Health and Social Survey surveyed 11 735 respondents in paid work and reported "significant" musculoskeletal pain in 11 body regions during the previous 12 months and a range of personal, physical, and psychosocial risk factors. Five studies concerning risk factors for four musculoskeletal outcomes were carried out on these data. Each included analyses with multiple logistic regression (MLR) performed separately for women, men, and the total study population. The results from these gender-stratified and unstratified analyses were compared.

Results In the unstratified MLR models, gender was significantly associated with musculoskeletal pain in the neck and lower extremities, but not with low-back pain. The gender-stratified MLR models identified significant associations between each specific musculoskeletal outcome and a variety of personal characteristics, and physical and psychosocial workplace exposures for each gender. Most of the associations, if present for one gender, were also found in the total population. But several risk factors present for only one gender could be detected only in a stratified analysis, whereas the unstratified analysis added little information.

Conclusions Stratifying analyses by gender is necessary if a full range of associations between exposures and MSD is to be detected and understood.

Key terms back pain; epidemiology; gender-based analysis; lower limb pain; neck pain; occupational health; woman.

Several studies have reported many male–female differences in the prevalence of some symptoms of work-related musculoskeletal disorders (1–6). Punnett & Herbert have outlined many possible origins of the observed disparities: differential exposures; interactions between exposures and gender; effect modification due to male/female social roles, genetics, psychology and physiology; differential pain experience, reporting or care-seeking (7). Differences in exposure by gender have received particular attention in several recent studies (1, 6, 8, 9). Researchers have also considered the methods used to take into account gender differences in the prevalence of work-related musculoskeletal disorders in epidemiologic studies (10–12). Two practices commonly used to overcome the problem of gender-specific exposures are stratification by gender and adjustment for gender accompanied by the verification of interactions with gender. Stratification involves a loss of statistical power, but adjusting for gender in unstratified analyses, even if interactions with gender are verified, can prevent the recognition of gender-specific risks. Such a lack of recognition was observed in a study of sickness absence

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in poultry processing (10). Using a single dataset, the objective of this study was to compare the two analytical strategies for several musculoskeletal outcomes in a population-based sample with a wide range of exposures.

The 1998 Québec Health and Social Survey provides an excellent dataset for these comparisons. In addition to numerous general health and social questions, it includes an extensive section on workplace exposure, as well as a modified version of the Nordic questionnaire on musculoskeletal symptoms (13). We describe five studies conducted using this dataset to identify risk factors for four different musculoskeletal outcomes (14, 15, unpublished data: Stock S, Tissot F, Messing K. Neck pain and work: the importance of interpersonal and emotional workplace exposures; Tissot F, Stock S, Messing K. Relations between low back pain and occupational exposures among those who work standing and those who work sitting).

Study population and methods

Study population

Data were taken from the 1998 Québec Health and Social Survey, a household-based population survey of a weighted, random sample of all residents outside institutions and Indian reserves in Québec, Canada. The final population sampled for the 1998 survey has been estimated to represent 97.3% of the target population. The following two data collection instruments were used in this study: an interviewer-administered questionnaire completed by a member of each household (at least 18 years of age), on behalf of the entire household, and a self-administered questionnaire completed by each member of the household aged ≥15 years. In all, 30 386 persons were sampled using the interviewer-administered questionnaire, while 20 773 respondents completed the self-administered questionnaire (weighted response rates of 82% and 84%, respectively). The weighted response rate for the overall self-administered questionnaire was 69%. At the time of the study, 11 735 respondents worked full- or part-time at a paid job for an employer or were self-employed.

This paper describes five studies of risk factors for the following four musculoskeletal problems in the aforementioned study population: (i) neck pain, (ii) low-back pain among sitting workers, (iii) low-back pain among standing workers, (iv) lower leg or calf pain, and (v) ankle or foot pain.

The studies did not include those who worked less than 25 hours (N=2509) per week or those who did not answer the questions concerning symptoms during the previous 12-month period (109≤N≥139, depending on the body site). Those with less than 12 months of seniority in their current job were excluded from the studies on low-back pain and lower-extremity symptoms (N=1005). There were also other minor differences in the selection criteria among these studies, for example, those who had a car accident (N=48) in the previous 12-month period were excluded from the multivariate analyses of the study on neck pain, while women who were pregnant (N=63) were excluded from the studies on low-back and lower-extremity pain. Details on analytical methods and variable selection have been described previously (15). The final multiple logistic regression (MLR) models of these five gender-stratified and unstratified studies are presented in the appendix, tables A to E.

Outcome

The questions concerning musculoskeletal symptoms were adapted from the standardized Nordic questionnaire (16). The respondents were presented a body 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 that interfered with your usual activities? (never; occasionally; fairly often; or all the time)." For all of the analyses, the case definition for each musculoskeletal outcome included persons who reported significant pain that interfered with usual activities "fairly often" or "all the time" in the body area in question during the past 12 months.

Exposures

We used a series of questions validated by an observational study (17) to assess work posture. First, the respondents were asked whether they usually sat or stood at work. If they usually stood, they were asked to characterize their usual work posture according to their ability to sit at will and according to the degree of mobility (fixed posture, moving a short distance, or moving a longer distance). The workers who usually sat were asked whether their posture was usually fixed or whether they could stand at will. The following five other measures of physical demands were included: (i) repetitive hand or arm movements (eg, assembly-line work, work speed determined by a machine or very fast rate of production), (ii) handling heavy loads (eg, lifting or carrying people or objects such as boxes, furniture), (iii) forceful exertion when using tools, machines or equipment, (iv) vibration from handheld or hand-operated tools (hand–arm vibration), and (v) vibration from large machinery, vehicles or the ground (whole-body vibration). The four original response categories were combined into two or three categories as follows: (i) "never or occasionally" versus "fairly often or all the time" or (ii) "never or occasionally" versus "fairly often" versus "all the time".

Using the two nine-item indices of the Karasek job content questionnaire (18), we assessed psychological job demands and decision latitude. For these two indices, the responses were classified according to the median score observed in the 1990 Québec Cardiovascular Health Survey (19) as "low versus high" decision latitude and "low versus high" psychological job demands. The workers exposed to both high psychological job demands and low decision latitude were defined as the high-strain group. Workers exposed to neither job constraint comprised the low-strain group. These variables were also categorized into tertiles to enable a comparison of the exposure groups according to low, medium, and high decision latitude and psychological job demand.

Four additional workplace psychosocial exposures were assessed that included: (i) physical violence, (ii) intimidation; (iii) unwanted sexual attention, and (iv) difficult or tense situations with the public. The response scale for violence, intimidation, and unwanted sexual attention was dichotomized into the categories "never" versus "occasionally, often or very often". The response scale for experiencing difficult or tense situations with the public at work was dichotomized into the categories "never, rarely or occasionally or no contact with public" versus "often or very often".

Weekly workhours were broken down into the following categories: (i) 25 to 35 hours/week, (ii) 36 to 40 hours/week, and (iii) >40 hours/week. Working the night shift and working an irregular shift schedule were also included in the studies. A variable combining long hours of paid work per week (>40 hours/week) and living with ≥2 children (<18 years of age) was created to represent the "double burden" of combining paid work with family obligations and was included in the studies on neck pain and low-back pain.

Personal factors

The sociodemographic variables included age (18–24, 25–39, 40–49, 50–65 years), education (holder versus nonholder of highschool diploma), having preschool children, and total number of children. The household income indicator was calculated using the ratio of household income to the poverty threshold income established by Statistics Canada for household size (quintiles). The quintiles (very poor, poor, lower middle income, upper middle income, or high income) were grouped somewhat differently in each study. Other individual variables included smoking (non-smoker, ex-smoker, or current smoker), body mass index [underweight (<20 kg/m^2), healthy (≥20<27 kg/m^2), overweight (≥27<30 kg/m^2), and obese (≥30 kg/m^2)], and leisure-time physical activity (response categories could be combined differently from one study to the other). The 14-item Psychiatric Symptoms Index (20) was used to assess psychological distress. A social support index (21) was also included in all of the studies.

Statistical analysis

All of the outcome prevalence estimates that are presented are weighted estimates. We carried out chi-square tests to assess the differences in the proportions between the men and women. We used MLR with a manual stepwise backward deletion approach to analyze the associations between risk factors and all work-related musculoskeletal disorders. We employed Hosmer and Lemeshow's variable selection process (22) for the studies with many potential explanatory variables, whereby any variable whose bivariate association with the outcome variable has a P-value of <0.25 is entered into the multivariate model along with all of the variables of known importance (15). The analyses were conducted separately for each gender throughout the process, the result being a final model for each gender (ie, gender-stratified analysis), while gender was treated as a potential confounder in the unstratified MLR analyses for the total study population (ie, unstratified analysis). Throughout the variable selection process for the unstratified analysis, we adjusted for gender in the bivariate analyses of each independent variable and systematically checked the interactions between gender and each variable.

The two-way interactions between variables were assessed, and, when present, they were included in the multivariate analyses. It should be noted that, when a significant two-way interaction between gender and a risk factor is present in the MLR models for the unstratified analyses, the association between gender and the outcome variable differs among the various categories of the risk factor. As a consequence, the odds ratio for the gender variable in the model reflects the gender effect of the workers represented by the reference category of the variable that interacts with gender. It does not reflect the gender effect for the total study population (22). Therefore, the P-value of the average gender effect was sought for each MLR for the total study population; it is noted in the footnote of each model for the total population in each table found in the appendix.

Since the same variable for physical work exposure can correspond to different physiological constraints on the back among sitting and standing workers, the analyses using low-back pain as the outcome were performed separately for the standing and sitting workers.

We evaluated the significance of all the models using a chi-square test and used the Hosmer–Lemeshow and deviance χ^2 goodness of fit statistics to assess the fit of the final logistic regression models (22). SAS software, version 9.1.3 (SAS Institute, Cary, NC, USA) and SUDAAN software, version 9.0 (Research Triangle Institute, Research Triangle Park, NC, USA) were used for the study on low-back and neck pain to account for the complex sampling design. For the studies concerning low-extremity pain, for which the SUDAAN software was not available at the time, the statistical analyses were carried out using SPSS, version 13.0 (SPSS Inc, Chicago, IL, USA), and a more stringent criterion for statistical significance was used (P=0.01). Sampling weights for all of the analyses were provided by the Institut de la Statistique du Québec (Québec Institute of Statistics) to make the sample representative of the population and correct for non-response (23).

Comparisons

We compared the statistically significant variables in the gender-stratified and unstratified analyses for each of the final MLR models from the five studies of musculoskeletal outcomes in order to determine whether any of them were significantly associated with the outcome among the following: (i) both male and female workers in the stratified and unstratified analyses for the total study population, (ii) male (but not female) workers and the total study population, (iii) female (but not male) workers and the total study population, (iv) male workers only but not in the unstratified analysis for the total study population, (v) female workers only but not in the unstratified analysis for the total study population, and (vi) male workers, or female workers, or both who were retained in the unstratified MLR model for the total study population because the variable interacted significantly with the gender variable.

Results

For each body region, table 1 presents crude female-to-male ratios for the prevalence of musculoskeletal pain that interfered with usual activities "fairly often or all the time" over the past 12 months. In this study population, the women had a significantly higher pain prevalence than the men with respect to the neck, upper back, shoulder, upper extremity, hips or thighs, lower legs or calves, and ankles or feet during the previous 12 months. The men had a significantly higher prevalence of knee pain. There was no significant gender difference for the prevalence of low-back pain. The greatest gender difference in the prevalence of musculoskeletal outcome was found for the neck (18.4% for the women versus 10.9% for the men). Overall, slightly more women than men reported pain in at least one site (48.2% versus 45.7%, respectively).

After controlling for all of the significant exposures and personal factors in the five unstratified MLR analyses for the total study population (see appendix tables), female gender was still strongly associated with neck pain, lower leg or calf pain, and foot or ankle pain. The gender effect in these three studies was highly significant (P<0.001). [See footnotes of appendix tables A, D, and E.] Gender was not significantly associated with low-back pain in either the sitting or standing study populations. However, for those who usually sat at work, there was a significant gender effect for the younger population (19–25 years) [odds ratio 5.19, P=0.004], female gender being associated with more low-back pain.

Prevalence of exposures

Male–female differences in exposure prevalence have been previously reported from this dataset (24). These prevalences varied slightly among the studies, which had slightly different criteria for inclusion. Table 2 shows the exposure prevalences reported in the study of lower limb pain (15).

Table 1. Estimates of prevalence of significant musculoskeletal pain that interfered with usual activities often or all the time in the previous 12 months by gender and crude female–male ratio, 1998 Québec working population aged 15 and over, working at least 25 hours per week.

Pain	Men (N=5434) (%) [a]	Women (N=4006) (%) [a]	Women/ men (ratio)
Neck [b]	10.9	18.4	1.69
Upper back [b]	11.4	17.1	1.51
Low back	25.6	23.4	0.91
Shoulders [b]	11.6	15.0	1.29
Arms	7.1	7.3	1.03
Elbows	5.0	4.0	0.80
Lower forearms, wrists or hands	7.5	8.7	1.16
Hips or thighs [c]	4.3	5.9	1.37
Knees [c]	9.8	7.3	0.75
Lower legs or calves [b]	5.3	8.2	1.54
Ankles or feet [b]	8.2	11.3	1.37
Upper extremity [d,e]	19.9	22.5	1.13
Distal lower extremity [f]	16.9	18.1	1.07
Any site [g]	45.7	48.2	1.05

[a] All estimates are weighted to reflect the population and adjusted with SUDAAN for the complex survey design.
[b] P-value ≤0.001.
[c] P-value <0.01.
[d] P-value <0.05.
[e] At least one site of pain in shoulders, arms, elbows, lower forearms, wrists or hands.
[f] At least one site of pain in knees, lower legs, calves, ankles or feet
[g] P-value =0.052 for difference between men and women.

Table 2. Prevalence of sociodemographic, non-occupational and occupational factors by gender, 1998 Québec working population aged 18–65 years, working at least 25 hours per week; from the study of lower limb pain.

	Men (N=4534) (%) [a]	Women (N=3223) (%) [a]	Total (N=7757) (%) [a]	P-value [b]
Age group				
25–39 years	5.7	5.6	5.7	.
15–24 years	41.2	43.2	42.0	.
40–49 years	31.6	33.6	32.4	.
≥50 years	21.6	17.7	20.0	<0.001
Household income	.	.	.	<0.001
Upper middle income or higher income	66.4	67.4	66.8	<0.001
Very poor, poor or lower middle income	33.6	32.7	33.2	.
Education	.	.	.	<0.001
Having a high-school diploma	71.6	80.2	75.1	.
No high-school diploma	28.5	19.8	24.9	.
Having a preschool child	.	.	.	<0.001
No	80.7	84.0	82.1	.
Yes	19.3	16.0	17.9	.
Number of children				
0	53.3	55.6	54.2	.
1	19.6	21.2	20.3	.
≥2	27.1	23.2	25.5	<0.001
Body mass index				
Healthy weight	61.8	66.9	63.9	<0.001
Underweight	3.3	12.8	7.1	<0.001
Overweight	22.1	9.7	17.1	<0.001
Obese	12.8	10.5	11.9	<0.05
Leisure physical activities				
Once a week or more	50.2	49.3	49.8	.
Once, twice or three times a month	20.5	25.0	22.3	<0.001
Never	29.2	25.8	27.8	<0.01
Smoking status				
Non-smoker	27.9	31.4	29.3	<0.05
Ex-smoker	35.9	34.6	35.4	.
Current smoker	36.3	34.0	35.4	.
Social support	.	.	.	<0.001
High	77.4	84.4	80.3	.
Low	22.6	15.6	19.7	.
Psychological distress	.	.	.	<0.001
Low	84.9	78.7	82.4	.
Elevated	15.1	21.3	17.6	.
Detailed working posture				
Sitting & possibility of getting up at will	30.7	43.0	35.7	<0.001
Standing & possibility of sitting down at will	10.6	9.3	10.1	.
Moving, long distances	27.1	15.0	22.2	<0.001
Moving, short distances	16.5	16.4	16.5	.
Standing, fixed/relatively fixed position	6.5	6.6	6.6	.
Sitting, constrained posture	8.6	9.8	9.1	.
Handling heavy loads				
Never or occasionally	76.9	89.5	82.0	<0.001
Fairly often	14.8	6.9	11.6	<0.001
All the time	8.3	3.6	6.4	<0.001
Repetitive work				
Never or occasionally	79.9	79.3	79.6	.
Fairly often	7.9	7.5	7.8	.
All the time	12.2	13.2	12.6	.
Forceful exertion				
Never or occasionally	72.7	93.6	81.1	<0.001
Fairly often	16.5	4.1	11.5	<0.001

	Men N=4534 (%) [a]	Women N=3223 (%) [a]	Total N=7757 (%) [a]	P-value [b]
Forceful exertion (continued)				
All the time	10.8	2.3	7.4	<0.001
Whole body vibrations				
Never or occasionally	89.6	99.3	93.5	<0.001
Fairly often	5.5	0.4	3.4	<0.001
All the time	5.0	0.3	3.1	<0.001
Hand-arm vibration				
Never or occasionally	85.6	97.8	90.5	<0.001
Fairly often	9.5	1.1	6.1	<0.001
All the time	5.0	1.2	3.4	<0.001
Difficult or tense situations with public	.	.	.	<0.01
Never, rarely, occasionally, no contact with public	73.9	69.9	72.3	.
Often or very often	26.1	30.1	27.7	.
Physical violence at work				
Never	97.3	96.6	97.0	.
Occasionally, often or very often	2.7	3.5	3.0	.
Intimidation at work				
Never	82.7	80.5	81.8	.
Occasionally, often or very often	17.3	19.5	18.2	.
Unwanted sexual attention at work	.	.	.	<0.001
Never	98.4	92.5	96.0	.
Occasionally, often or very often	1.6	7.5	4.0	.
Decision latitude	.	.	.	<0.001
High	50.2	39.2	45.7	.
Low	49.9	60.8	54.3	.
High psychological job demands				
Low	51.0	52.5	51.7	.
High	49.0	47.5	48.4	.
Decision latitude				
High	39.3	27.1	34.4	<0.001
Medium	32.1	35.0	33.3	<0.05
Low	28.6	37.9	32.4	<0.001
Psychological job demands				
Low	30.4	31.5	30.8	.
Medium	34.0	33.6	33.8	.
High	35.7	34.9	35.4	.
Job strain				
Low strain	21.5	18.2	20.1	<0.05
Passive	29.5	34.3	31.5	<0.001
Active	28.8	21.1	25.7	<0.001
High strain	20.2	26.4	22.7	<0.001
Night shift				
Never or occasionally	86.3	95.0	89.8	<0.001
Fairly often	7.5	2.4	5.4	<0.001
All the time	6.3	2.6	4.8	<0.001
Length of work week				
25–35 hours/week	13.7	44.8	26.3	<0.001
36 to 40 hours/week	52.6	44.1	49.1	<0.001
>40 hours/week	33.7	11.1	24.6	<0.001
Long hours of paid work (>40 hours/week) and ≥2 children (<18 years) at home	.	.	.	<0.001
Yes	9.4	2.8	6.8	.
No	90.6	97.2	93.3	.

[a] All estimates are weighted to reflect the population and adjusted with SUDAAN for the complex survey design.
[b] For difference between men and women, chi-square test.

Comparisons of the gender-stratified and unstratified analyses

Table 3 summarizes the variables shown to have a statistically significant association with each musculoskeletal outcome in the final MLR models for both the gender-stratified and gender-unstratified analyses for the total population. The detailed MLR results for each study, upon which table 3 is based, are presented in the appendix. There was only a single case in which a variable was significantly associated with the outcome only in the unstratified analysis (intimidation at work and low-back pain among standing workers). It should be noted that this association was of borderline statistical significance (P= 0.081) among males in the stratified analysis (appendix table C). There were several cases in which the stratified analyses supplemented the information obtained from the unstratified analyses.

The first column of table 3 presents the variables significantly associated with the outcome among both the male and female workers in the stratified analyses and also in the unstratified analysis for the total population.

The second column presents the variables significantly associated with outcome among the male but not the female workers. Some of these variables, identified in table 3 by the superscript "c" and the corresponding footnote (eg, education and neck pain, whole-body vibration, and low-back pain among the sitting workers) were not significant in the unstratified MLR model for the total study population. The third column presents the variables significantly associated with outcome among the female but not the male workers. Variables such as leisure-time exercise and low-back pain among the sitting and standing workers, unwanted sexual attention, and low-back pain among the standing workers, handling heavy loads, and both lower leg or calf pain and ankle or foot pain were not significant in the unstratified analysis for the total study population (variables also identified with the superscript "a" in table 3). It is noteworthy that many variables were significantly associated with work-related musculoskeletal disorders for one gender but not the other. In many such cases, the association did not hold at all for the other gender and therefore was not observed in the unstratified analysis.

The last column of table 3 contains the variables that were significantly associated with the outcome in only one of the gender-stratified analyses and also in the unstratified analysis for the total study population (relationships clearly present for only one gender and the total population). In this column we also included variables that were significantly associated with outcome among male workers and/or female workers but were only retained in the unstratified analysis for the total study population because the variable interacted significantly with the gender variable. This situation has been identified by footnote "b" in the table. In almost all of these situations, the variable was significant in only one of the stratified analyses. There was one exception. The association between smoking and low-back pain among the standing workers was significant in both models, but in the opposite direction (ie, for the men there was a positive association between smoking and low-back pain, while for the women there was an inverse relationship). There are other examples that highlight the importance of taking into account the gender interaction term; they include the following: (i) the association between neck pain and an age of ≥40 years among women (appendix table A), (ii) the association between low-back pain among standing women and difficult and tense situations with the public, and (iii) the association between low-back pain among standing women and the combination of >40 hours/week of paid work and having two or more children under 18 years of age at home (appendix table C).

Taking into account the interactions between gender and other variables during the variable selection process for the MLR modeling influenced which variables were included in the models. If the bivariate analyses for the total population had only been adjusted for gender, but interactions with gender had not been verified at this stage, some variables would not have met the selection criterion of P<0.25 and, therefore, would not have been included in the unstratified multivariate analyses.

Table 4 presents an example derived from the analyses for neck pain, using the combination variable ">40 hours/week of work and having ≥2 children." In the bivariate analyses, this variable was significant for the women but not for the men. In the unstratified bivariate analyses, if only gender had been adjusted for and the interaction between this variable and gender had not been taken into account, the variable would not have met the selection criteria of P<0.25. However, when the interaction term was taken into account, it was retained for the MLR modeling. In fact, this variable was significant in the final unstratified model (appendix table A). Similar situations arose with variables in the studies of both lower-extremity sites. [See appendix tables D and E.]

Discussion

Principal findings

As has been found in other studies, we observed the following: (i) the prevalence of reported neck pain, upper-back pain, shoulder pain, hip or thigh pain, lower leg or calf pain, and ankle or foot pain was higher for women, (ii) the prevalence of reported knee pain was higher for men, and (iii) there was no significant gender difference

Table 3. Variables shown to have a statistically significant association with each musculoskeletal outcome in final gender stratified MLR models and in unstratified MLR models for the total study population.

	Variables significant among both male and female workers in stratified MLR models *and* in unstratified MLR models for total population	Variables significant *only among male workers* in the stratified MLR models	Variables significant *only among female workers* in the stratified MLR models	Variables significant in unstratified MLR models for the total population *and* in *only one* of the stratified analyses (male or female)
Neck pain [a]	Sitting posture Repetitive hand or arm movements Intimidation at work High psychological job demands	Hand-arm vibration Whole body vibration Difficult situation with public Handling heavy loads (inverse relationship)	Unwanted sexual attention >40 hours/week paid work) and ≥2 children (<18 years) at home	Hand-arm vibration Whole body vibration Difficult situation with public Unwanted sexual attention >40 hours/week paid work and ≥2 children (<18 years) at home [b] Handling heavy loads (inverse relationship)
	High psychological distress	Absence of leisure physical activities Having a high school diploma [c]	Being an ex-smoker Age ≥40 years	Absence of leisure physical activities Being an ex-smoker Age ≥40 years [b]
Low back pain among sitting workers [d]	Forceful exertion Difficult or tense situations with the public	Night shift Whole body vibration [c, e]	High job strain	Night shift High job strain
	High psychological distress	Age 40–49 years [e]	Age 18–24 years Exercising once or twice per week [c]	Age 18–24 years Age 40–49 years [b, e]
Low back pain among standing workers [f]	Moving around [g] Handling heavy loads all the time High psychological job demands	Standing in a fixed position [g] Hand-arm vibration Handling heavy loads fairly often Intimidation at work [e]	Difficult situation with public >40 hours/week paid work and ≥2 children (<18 years) at home Unwanted sexual attention [c]	Standing in a fixed position [g] Hand-arm vibration Handling heavy loads fairly often [e] Intimidation at work Difficult situation with public [b] >40 hours/week paid work and ≥2 children (<18 years) at home [b]
	High psychological distress Leisure physical activities once or twice a week (inverse relationship)	Smoking Being an ex-smoker [e]	Age 18–24 years Overweight Exercising ≥three times a week (inverse relationship) [c] Smoking (inverse relationship)	Age 18–24 years Overweight [e] Smoking [b] Smoking (inverse relationship) [b, e] Being an ex-smoker [b]
Lower leg/calf pain [h]	Moving around, longer distance [i] Moving around, short distance [i] Standing in a fixed position [i]	Standing with the possibility of sitting down at will [e] Whole body vibration Intimidation at work Passive job strain (inverse relationship)	Handling heavy loads all the time Handling heavy loads fairly often [c]	Standing with the possibility of sitting down at will Whole body vibration Intimidation at work Passive job strain (inverse relationship) [e] Handling heavy loads all the time
	High psychological distress Age ≥50 years	Absence of leisure physical activities Having a preschool child Underweight	Age 40–49 years Lower household income	Absence of leisure physical activities Age 40–49 years Lower household income [e] Having a preschool child [b] Underweight [b]
Ankle/foot pain [j]	Moving around, longer distance [i] Moving around, short distance [i] Standing in a fixed position [i]	Standing with the possibility of sitting down at will [c, e, i] Whole body vibration Intimidation at work	Repetitive hand and arm movements Handling heavy loads all the time [c, e]	Whole body vibration Intimidation at work Repetitive hand and arm movements
	High psychological distress Age ≥50 years Lower household income	Obesity Underweight [e] Having a preschool child	Age 18–24 years [e]	Obesity Age 18–24 years [e] Underweight [b, e] Having a preschool child [b]

[a] See appendix table A
[b] The variable was retained in the model for the total population because it interacted significantly with gender
[c] The variable was significant among female workers *or* among male workers in the gender stratified analyses *but not* in the unstratified analysis for the total study population
[d] See appendix table B
[e] Tendency
[f] See appendix table C
[g] Reference category: Standing with freedom to sit at will
[h] See appendix table D
[i] Reference category: Sitting with freedom to stand up at will
[j] See appendix table E

Table 4. Example of a bivariate analysis in cases where the study variable would not have been retained for inclusion in the unstratified multiple logistic regression (MLR) analysis for total study population if the interaction term with gender had not been included in the initial bivariate analysis; crude odds ratios (OR) of neck pain.

Risk factors	Gender-stratified MLR analysis				Unstratified MLR analysis for total population					
	Men		Women		Adjusted for gender		Adjusted for gender + interaction term (ref=male)		Adjusted for gender + interaction term (ref=female)	
	OR	P-value	OR	P-value	OR	P-value	OR	P-value	OR	P-value
>40 hours/week ≥2 children (<18 years) at home										
No	1.0	·	1.0	·	1.0	·	1.0	·	1.0	·
Yes	0.85	0.369	1.52	0.106	1.02	0.914 [a]	0.85	0.369 [b]	1.52	0.106 [c]
Gender										
Male	·	·	·	·	1.0	·	1.0	·	0.56	0.000
Female	·	·	·	·	1.85	0.000	1.79	0.000	1.0	·
>40 hours/week ≥2 children (<18 years) at home *by* gender (interaction)	·	·	·	·	·	·	1.80	0.043	0.56	0.043

[a] This P-value is much higher than 0.25, the criterion used for inclusion in the multivariate analyses.
[b] P-value of the risk factor among male workers.
[c] P-value of the risk factor among female workers.

for reported low-back pain (25). In the multivariate analyses, female gender was significantly associated with neck pain, lower-leg or calf pain, and foot or ankle pain in the final model for the total population after controlling for all of the other significant workplace exposures and personal factors measured in the study. A relationship between gender and these musculoskeletal outcomes has been found in other studies (26–28).

This study demonstrates the importance of stratifying analyses by gender. Had the stratification not been done, several risk factors would have been missed, while some associations would have been erroneously assumed to be present for both genders when they were, in fact, present for only one. With the unstratified analyses, several associations with risk factors would have been overlooked had the interaction terms not been included, particularly when the relationships between an outcome and an exposure variable went in opposite directions for the men and women. Given the fact that women and men are usually found in relatively segregated jobs (12), only very large study populations or the oversampling of nontraditional job assignments would allow analyses with all relevant interaction terms. Consequently, a stratified analysis is preferable for most study populations.

Possible explanations for the gender differences

If stratified analyses are to be conducted, it is important to know how to interpret the results in order to protect all workers. If a risk is found for one gender, does it mean that it is only a risk for that gender? Gender differences in the associations between the independent and outcome variables in the MLR models can be explained in several ways. First, and most commonly, gender differences appeared when the prevalence of an exposure was very low for one gender, even though a bivariate association or tendency was found for both genders. This was the case, for example, for exposure to whole-body vibration among the women and unwanted sexual attention among the men (see table 2). The low prevalence of these work exposures for one gender likely reflects the gendered division of labor and gender-specific exposures (12). It is important to derive study instruments from information on potential workplace exposures that are found in jobs held by both genders.

However, not all of the differences in the associations were due only to a low prevalence. A second type of situation could occur if the survey instrument did not measure the same exposure for both genders, namely, if the crude questionnaire-based measure of some work exposures was unable to distinguish fine differences in intensity, frequency, or type of exposures that may exist between women and men. For example, in columns 3, 4 and 5 of table 3, "handling heavy loads" (about 10% of the women, 23% of the men) could correspond, among the women and men, to loads with different characteristics. A large proportion of the "heavy loads" handled by women may be patients or children, who are not inert and must be handled in specific ways. Among the top 20 professions of women in Québec, four are of this type (nurse, preschool or primary school teacher, healthcare auxiliary worker, and daycare worker). None of the top 20 male professions are of this type (29). "Repetitive work" (about 20% of both genders) can also correspond to different types of exposure; for example, the speed of repetition and associations with posture can differ according to gender (30, 31), corresponding in some cases to intrastratum confounding (12). In addition, ergonomic and other qualitative studies have shown that, even when women and men do the same jobs, they may be exposed to different risk factors due to interactions between body size and work requirements (32, 33).

Third, the exposure variable could have corresponded to different extra-professional contexts among the women and men, as might be the case, for example, with "works <40 hours/week and lives with ≥2 children", which was associated with low-back pain among the women who worked standing but not among the men who worked standing. This variance may be related to differences in the workload associated with caring for children among the women when they are compared with men. Gendered exposures outside the workplace may interact with workplace exposures and lead to generalized fatigue, psychological distress, or the overuse of certain musculoskeletal structures. Other researchers have found gender differences in the associations between long workhours and health (34). In short, the same variable measured with a questionnaire can correspond to different cumulative exposures according to gender. In this case, better measurement of the exposures associated with domestic responsibilities would have been useful in trying to understand the nature of this relationship.

Fourth, the assessed characteristic or exposure could have been a surrogate for another, unmeasured variable that was associated with the outcome primarily for one gender. This could have been the case with the relationship between a higher level of education and neck pain among the men. It is possible that the men with comparatively little education may not have been exposed to the unmeasured conditions that might cause neck pain among men, for example, computer work. Among the women, it is possible that these unmeasured risk factors are not associated with the level of education. Women in Québec have, on the average, more years of education than men (35).

Finally, biological or psychological differences between the women and men may have acted as effect modifiers, affecting the relationships between the exposures and outcomes. For example, women have the possibility of experiencing perimenstrual work-related back pain (36). Such hormonal differences are often mentioned or implied as an exclusionary diagnosis in the case of a gender difference in prevalence when no exposure differences can be found (8, 37, 38). However, in the absence of complete information on exposures, caution is needed in interpreting gender differences as biological in origin. For example, some authors have excluded exposure differences from their interpretation of gender differences in outcome when only one or two exposures have been considered (37).

Role of interactions

In this study, several gender interaction effects were detected. The situations were of two general types: (i) the relationship between exposure and outcome was either significant for one gender but no relationship could be observed in the other (odd ratio ~ 1) or (ii) opposite effects were observed for the two genders.

The variable selection process for multivariate modeling can be a problem in mixed-gender populations, given the numerous male–female differences in frequency and the type of professional and non-professional exposures (7, 12). Several variables may be inappropriately eliminated from consideration if gender interactions are not verified for each variable in the first stages of variable selection on the basis of bivariate analyses. As these results demonstrate, it is not sufficient to adjust for gender in the bivariate analyses. In addition, if the working population under study had included relatively few members of the gender for the occurring association, it might not have emerged from the bivariate analysis at all.

Conducting gender-stratified analyses avoids these problems. In MLR modeling, stratification by gender is preferable to the inclusion of gender interaction terms in an unstratified analysis because the number of interaction terms could be very high in some cases and could result in an "overfitted" model. Overfitting could affect the accuracy of the associations between workplace risk factors and musculoskeletal disorders (22, 39).

Strengths and weaknesses of the study

The findings were affected to some degree by the design of the Québec Health and Social Survey, which was a population-based, general survey with a necessarily limited number of questions on occupational risk factors. As has been noted by other researchers (34), there is a particular dearth of research on exposures in the types of jobs that are generally assigned to women. Moreover, the survey instrument in the current study was not able to assess physical work exposures for which observation or direct measurement would be appropriate. For example, the questionnaire did not measure static effort (except for standing), joint postures, cycle times, break times, or weights lifted nor did it assess work factors that hinder work–family balance, such as unpredictable schedules or the ability to receive and make telephone calls at work. However, the inclusion of several psychosocial work exposure measures, including several appropriate to the service sector in which most women (and men) work, was a strength of this survey instrument.

The study relied on self-reported symptoms and exposures and was limited (or enhanced) by the ability of such reporting to identify musculoskeletal disorders.

In particular, gender differences in the reporting of pain (40), including the reporting of work-related pain on body maps (41), have been found with variable interpretations of the differences (42).

Observational studies are therefore a necessary complement to questionnaire surveys, although observational studies involving large groups necessarily rely on sampling over short time periods with its associated uncertainty (43).

MLR was employed to model prevalence ratios in these cross-sectional analyses. This technique can overestimate prevalence ratios when the outcome is common, as it was for back pain and upper-extremity pain (44). However, in this study, gender differences in prevalence were low for these two disorders, and therefore the results reported here should not have been affected.

Implications for future research

Gender is not the only social characteristic that relates both to exposure and occupational health outcome (45). Visible minority status, language, cultural group, and immigration status are also associated with exposures to risk factors for musculoskeletal disorders and with reporting and receiving compensation for occupational disorders (46–50). Education and other indicators of socioeconomic status have also been linked to exposures and outcomes, and, in addition, such relationships differ according to gender (25, 51). Stratifying for all of these at once is not usually possible with the sample sizes normally available. Cluster analyses have succeeded in defining multifaceted groups whose social characteristics can then be explored (52), but the usefulness of information at this level of complexity for public health prevention has not yet been shown. Qualitative research is needed to examine mechanisms whereby social groupings influence exposures and outcomes. More sophisticated statistical techniques may also be helpful.

Concluding remarks

Large-scale population-based surveys allow for multivariate analyses that control for a wide range of personal factors and can take into account a spectrum of occupational and nonoccupational exposures. They can, thus, identify potential new risk factors that can be confirmed in prospective studies. Moreover, large-scale surveys that are representative of the total working population provide access to workers in small and non-unionized work environments, which are often difficult for researchers to study. If information on the relationship between gender and health is to be obtained from these studies, stratified analyses should be conducted and the possible mechanisms underlying the associations between gender, risk factors, and health should be explored.

Although useful and necessary, such population-based studies are limited in their potential for a complete understanding of gender differences in exposures. Prospective, workplace-based studies – which can include more detailed qualitative data, as well as standardized observations and direct measurement of biomechanical, work organization, and psychosocial exposures – permit a more complete appreciation of the relationships between exposure and musculoskeletal disorders and gender differences in exposure.

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Appendix - Multiple logistic regression models

Table A. Risk factors associated with significant neck pain among men, women and total population: results of the final logistic model, 1998 Québec working population aged ≥15 years, working at least 25 hours per week. (Adj OR = adjusted odds ratio, 95% CI = 95% confidence interval, WBV = whole body vibration, HAV = hand-arm vibration)

	Men [a]		Women [a]		Total population [a]	
	Adj OR	95% CI	Adj OR	95% CI	Adj OR	95% CI
Gender						
Male	..	.	..	.	1.0	.
Female	..	.	..	.	1.28	0.98–1.69 [f]
Age group						
15–39 years	..	.	1.0	.	1.0	.
≥40 years	..	.	1.31	1.04–1.65 [b]	0.94	0.73–1.20
Age group (years) *by* gender	..	.	..	.	1.41	1.01–1.98 [b]
Education						
Having a high-school diploma	1.0	.	..	.	1.0	.
No high-school diploma	0.70	0.51–0.96 [b]	..	.	0.87	0.70–1.08
Leisure-time physical activity level						
Once a week or more	1.0	.	..	.	1.0	.
Once, twice or 3 times a month	1.22	0.90–1.66	..	.	1.09	0.89–1.34
Never	1.45	1.11–1.90 [c]	..	.	1.30	1.07–1.57 [d]
Long hours of paid work (>40 hours/week) and ≥2 children (<18 years) at home						
No	..	.	1.0	.	1.0	.
Yes	..	.	2.07	1.18–3.63 [b]	0.72	0.48–1.07
Long hours of paid work (>40 hours/week) and ≥2 children (<18 year) at home *by* gender (interaction)	..	.	..	.	2.79	1.47–5.28 [d]
Smoking status						
Non-smoker	..	.	1.0	.	1.0	.
Ex-smoker	..	.	1.43	1.08–1.89 [b]	1.29	1.06–1.57 [b]
Smoker	..	.	1.12	0.82–1.52	1.14	0.92–1.41
General working posture						
Standing	1.0	.	1.0	.	1.0	.
Sitting	1.33	1.01–1.75 [b]	1.35	1.08–1.68 [c]	1.37	1.15–1.63 [e]
Repetitive hand and arm movements						
Never or occasionally	1.0	.	1.0	.	1.0	.
Fairly often or all the time	1.54	1.15–2.05 [d]	1.56	1.21–2.02 [e]	1.51	1.23–1.86 [e]
Handling heavy loads						
Never or occasionally	1.0	.	..	.	1.0	.
Fairly often or all the time	0.60	0.43–0.83 [d]	..	.	0.60	0.44–0.81 [e]
Handling heavy loads *by* gender	..	.	..	.	1.70	1.11–2.58 [b]
Whole body vibration and/or hand-arm vibration						
Never or occasionally	1.0	.	..	.	1.0	.
Fairly often or all the time hand-arm vibration	1.75	1.15–2.68 [c]	..	.	1.67	1.17–2.38 [d]
Fairly often or all the time hole body vibration	1.70	1.05–2.76 [b]	..	.	1.93	1.24–3.01 [d]
Fairly often or all the time to both types of vibration	2.07	1.28–3.35 [d]	..	.	1.87	1.15–3.05 [b]
Intimidation at work						
Never	1.0	.	1.0	.	1.0	.
Occasionally, often or very often	1.37	1.01–1.86 [b]	1.33	1.01–1.75 [b]	1.28	1.03–1.58 [b]
Unwanted sexual attention at work						
Never	..	.	1.0	.	1.0	.
Occasionally, often or very often	..	.	1.58	1.07–2.35 [b]	1.57	1.10–2.24 [b]
Difficult or tense situations with public						
Never, rarely, occasionally or no contact with public	1.0	.	..	.	1.0	.
Often or very often	1.35	1.02–1.77 [b]	..	.	1.25	1.04–1.51 [b]
Psychological job demands						
Low	1.0	.	1.0	.	1.0	.
Medium	1.09	0.80–1.49	1.14	0.86–1.50	1.11	0.90–1.38
High	1.36	1.03–1.81 [b]	1.86	1.39–2.48 [e]	1.61	1.29–2.00 [e]
Psychological distress						
Low	1.0	.	1.0	.	1.0	.
Higher	1.97	1.50–2.58 [e]	1.85	1.43–2.39 [e]	1.88	1.54–2.29 [e]

[a] Hosmer and Lemeshow goodness of fit test: P=0.217 for the model for male workers; P=0.790 for the model for female workers; P=0.589 for the model for the total study population.
[b] P-value ≤0.05.
[c] P-value ≤0.01.
[d] P-value ≤0.005.
[e] P-value ≤0.001.
[f] This OR for the gender variable reflects the gender effect of workers under the age of 40 and not doing more than 40 hours of paid work per week with 2 or more children at home (corresponding to the reference categories of all the variables interacting with gender); The average gender effect for the total population is significant (P-value <0.001), with female gender associated with more pain.

Table B. Risk factors associated with significant low back pain that interfered with usual activities in the previous 12 months among men, women and total population: results of the final logistic regression models, 1998 Québec working population aged 18 to 65 years, working at least 25 hours per week and working mostly in a sitting posture. Weighted data analyzed with the SUDAAN logistic regression procedure. (Adj OR = adjusted odds ratio, 95% CI = 95% confidence interval)

	Men [a]		Women [a]		Total sitting population [a]	
	Adj OR	95% CI	Adj OR	95% CI	Adj OR	95% CI
Gender						
Male	..	.	..	.	1.0	.
Female					1.39	0.95–2.04 [h]
Age group						
25–39 years	1.0	.	1.0	.	1.0	.
18–24 years	0.92	0.36–2.33	3.39	1.55–7.42 [d]	0.92	0.41–2.03
40–49 years	1.42	0.98–2.05 [f]	0.80	0.56–1.14	1.42	0.98–2.05 [f]
≥50 years	1.13	0.74–1.73	0.75	0.44–1.30	1.10	0.73–1.66
Age group *by* gender (interaction)						
18–24 years	..	.	..	.	3.73	1.19–11.63 [b]
40–49 years	..	.	..	.	0.58	0.35–0.97 [c]
≥50 years	..	.	..	.	0.72	0.37–1.40
Household income						
Higher income	1.0	.	..	.	..	.
Upper middle income	0.78	0.50–1.21	..	.	..	.
Lower middle income	1.41	0.87–2.27	..	.	..	.
Poor or very poor	0.93	0.37–2.35	..	.	..	.
Body mass index, kg/m^2						
Healthy weight (20 to 26.9)	1.0	.	1.0	.	1.0	.
Underweight (<20)	0.84	0.26–2.76	0.67	0.40–1.12	0.68	0.43–1.08
Overweight (27 to 29.9)	1.14	0.73–1.78	0.83	0.48–1.42	1.00	0.72–1.40
Obese (≥30)	1.19	0.77–1.84	1.43	0.87–2.35	1.22	0.88–1.69
Leisure physical activities						
Three times a month or less	1.0	.	1.0	.	..	.
Once or twice a week	0.90	0.63–1.29	1.44	0.99–2.08 [g]	..	.
3 times a week or more	1.29	0.83–1.99	1.24	0.79–1.95	..	.
Night shift						
Never or occasionally	1.0	.	..	.	1.0	.
Fairly often	0.93	0.53–1.64	..	.	1.08	0.62–1.85
All the time	2.25	1.08–4.69 [b]	..	.	2.25	1.21–4.18 [b]
Forceful exertion						
Never or occasionally	1.0	.	1.0	.	1.0	.
Fairly often or all the time	1.82	1.12–2.96 [b]	3.02	1.05–8.65 [b]	2.43	1.61–3.66 [e]
Whole body vibration						
Never or occasionally	1.0	.	..	.	..	.
Fairly often or all the time	1.70	0.97–2.99 [f] .	..	.	..	.
Difficult or tense situations with public						
Never, rarely, occasionally or no contact with public	1.0	.	1.0	.	1.0	.
Often or very often	1.69	1.20–2.37 [d]	1.79	1.27–2.52 [e]	1.74	1.40–2.17 [e]
Job strain						
Low strain PD$^-$ DL+	1.0	.	1.0	.	1.0	.
Passive PD$^-$ DL$^-$	1.21	0.73–2.02	1.20	0.69–2.06	1.22	0.84–1.78
Active PD+ DL+	1.04	0.65–1.69	1.36	0.78–2.37	1.15	0.81–1.62
High strain PD+ DL$^-$	1.37	0.78–2.40	1.81	1.06–3.09 [b]	1.58	1.10–2.27 [b]
Psychological distress						
Low	1.0	.	1.0	.	1.0	.
Elevated	2.22	1.50–3.27 [e]	1.98	1.37–2.88 [e]	2.08	1.60–2.72 [e]

[a] Hosmer and Lemeshow goodness of fit test: P = 0.714 for the model for male workers; P = 0.150 for the model for female workers; P = 0.363 for the model for the total study population.
[b] P-value ≤0.05.
[c] P-value ≤0.01.
[d] P-value ≤0.005.
[e] P-value ≤0.001.
[f] P-value ≤0.065.
[g] P-value = 0.054.
[h] This OR for the gender variable reflects the gender effect of workers aged 25–39 (corresponding to the reference category of the variable age which is interacting with gender). The average gender effect for the total population is not significant.

Table C. Risk factors associated with significant low back pain that interfered with usual activities in the previous 12 months among men, women and total population: results of the final logistic regression models, 1998 Québec working population aged 18 to 65, working at least 25 hours per week and working mostly in a standing posture. Weighted data analyzed with the SUDAAN logistic regression procedure. (Adj OR = adjusted odds ratio, 95% CI = 95% confidence interval)

	Men [a]		Women [a]		Total standing population [a]	
	Adj OR	95% CI	Adj OR	95% CI	Adj OR	95% CI
Gender [g]						
Male	..	.	..	.	1.0	.
Female	..	.	..	.	1.16	0.76–1.78
Age group						
25–39 years	1.0	.	1.0	.	1.0	.
18–24 years	1.11	0.72–1.71	1.88	1.07–3.29 [b]	1.44	1.02–2.03 [b]
40–49 years	0.94	0.71–1.24	0.72	0.48–1.10	0.88	0.69–1.13
≥50 years	1.23	0.88–1.72	1.03	0.64–1.64	1.21	0.91–1.60
Body mass index						
Healthy weight (20 to 26.9 kg/m^2)	1.0	.	1.0	.	1.0	.
Underweight (<20 kg/m^2)	1.46	0.77–2.78	1.36	0.81–2.29	1.38	0.93–2.06
Overweight (27 to 29.9 kg/m^2)	1.15	0.86–1.53	2.01	1.21–3.33 [c]	1.26	0.98–1.62
Obese (≥30 kg/m^2)	1.04	0.72–1.51	0.78	0.46–1.32	0.93	0.67–1.27
Leisure physical activities						
Three times a month or less	1.0	.	1.0	.	1.0	.
1–2 a week	0.69	0.52–0.93 [b]	0.64	0.44–0.93 [b]	0.68	0.54–0.86 [d]
≥3 times a week	1.01	0.72–1.42	0.59	0.39–0.92 [b]	0.89	0.68–1.17
Smoking status						
Non-smoker	1.0	.	1.0	.	1.0	.
Ex-smoker	1.34	0.97–1.86	0.94	0.63–1.39	1.42	1.02–1.97 [b]
Current smoker	1.59	1.16–2.17 [c]	0.64	0.42–0.98 [b]	1.60	1.17–2.21 [d]
Smoking status *by* gender (interaction)						
Ex-smoker *by* gender	..	.	..	.	0.65	0.40–1.06
Current smoker *by* gender	..	.	..	.	0.43	0.25–0.72 [d]
Long hours of paid work (>40 hours/week) and ≥2 children (<18 years) at home						
No	..	.	1.0	.	1.0	.
Yes	..	.	3.08	1.36–6.99 [b]	0.99	0.64–1.53
Long hours of paid work *by* gender (interaction)	..	.	..	.	2.99	1.04–8.57 [b]
Detailed working posture						
Standing with the possibility of sitting down at will	1.0	.	1.0	.	1.0	.
Moving around	1.66	1.13–2.44 [c]	1.61	1.00–2.60 [b]	1.62	1.19–2.20 [d]
Standing in a fixed or relatively fixed position	2.02	1.22–3.34 [c]	1.48	0.80–2.74	1.67	1.12–2.48 [b]
Handling heavy loads						
Never or occasionally	1.0	.	1.0	.	1.0	.
Fairly often	1.34	1.01–1.78 [b]	1.06	0.66–1.71	1.27	0.99–1.62 [f]
All the time	1.64	1.12–2.40 [b]	2.83	1.50–5.34 [d]	1.83	1.31–2.55 [e]
Hand-arm vibration						
Never or occasionally	1.0	.	..	.	1.0	.
Fairly often	1.72	1.23–2.41 [d]	..	.	1.77	1.29–2.44 [e]
All the time	1.70	1.11–2.61 [b]	..	.	1.64	1.10–2.45 [b]
Difficult or tense situations with public						
Never, rarely, occasionally or no contact with public	..	.	1.0	.	1.0	.
Often or very often	..	.	1.58	1.11–2.25 [b]	0.98	0.73–1.31
Difficult or tense situations with public *by* gender (interaction)	..	.	..	.	1.62	1.04–2.52 [b]
Unwanted sexual attention at work						
Never	..	.	1.0			
Occasionally, often or very often	..	.	1.94	1.10–3.40 [b]	..	.
Intimidation at work						
Never	1.0	.	..	.	1.0	.
Occasionally, often or very often	1.33	0.96–1.84	..	.	1.30	1.01–1.67 [b]
Psychological job demands						
Low	1.0	.	1.0	.	1.0	.
Medium	1.21	0.89–1.64	1.67	1.12–2.48 [b]	1.34	1.05–1.71 [b]
High	1.49	1.10–2.02 [c]	1.68	1.12–2.52 [b]	1.50	1.17–1.92 [d]
Psychological distress						
Low	1.0	.	1.0	.	1.0	.
Elevated	1.73	1.28–2.35 [e]	2.19	1.52–3.17 [e]	1.88	1.47–2.41 [e]

[a] Hosmer and Lemeshow goodness of fit test: P = 0.748 for the model for male workers; P = 0.365 for the model for female workers; P = 0.834 for the model for the total study population.
[b] P-value ≤0.05.
[c] P-value ≤0.01.
[d] P-value ≤0.005.
[e] P-value ≤0.001.
[f] P-value =0.055.
[g] This OR for the gender variable reflects the gender effect of workers that are non smokers, not doing more than 40 hours of paid work per week with 2 or more children at home and who are never, rarely or occasionally exposed to difficult or tense situations with public (corresponding to the reference categories of all the variables interacting with gender). The average gender effect for the total population is not significant.

Table D. Risk factors associated with significant lower leg/calf pain that interfered with usual activities in the previous 12 months among men, women and total population: results from the final logistic regression models, 1998 Québec working population aged 18 to 65, working at least 25 hour/week. (Adj OR = adjusted odds ratio, 99% CI = 99% confidence interval)

	Men [a]		Women [a]		Total population [a]	
	OR	99% CI	OR	99% CI	OR	99% CI
Gender						
Male	..	.	..	.	1.0	.
Female	..	.	..	.	2.72	1.87–3.95 [g]
Age						
25–39 years	1.0	.	1.0	.	1.0	.
18–24 years	0.59	0.22–1.62	1.30	0.59–2.83	0.91	0.50–1.67
40–49 years	1.43	0.88–2.32	1.78	1.12–2.84 [e]	1.56	1.11–2.21 [e]
50–65 years	2.19	1.28–3.75 [e]	2.96	1.78–4.91 [e]	2.45	1.67–3.59 [e]
Household income						
Upper-middle- or higher-income quintiles	..	.	1.0	.	1.0	.
Very poor, poor, or lower-middle-income quintiles	..	.	1.51	1.02–2.23 [c]	1.31	0.99–1.72 [f]
Having a preschool child						
No	1.0	.	..	.	1.0	.
Yes	1.88	1.15–3.08 [e]	..	.	1.86	1.17–2.96 [e]
Having a preschool child *by* gender (interaction)					0.38	0.18–0.81 [e]
Body mass index						
Healthy weight (20–26.9 kg/m²)	1.0	.	1.0	.	1.0	.
Underweight (<20 kg/m²)	3.04	1.46–6.33 [e]	0.95	0.53–1.72	2.71	1.32–5.60 [e]
Overweight (27–29.9 kg/m²)	1.02	0.64–1.62	0.69	0.33–1.43	1.06	0.67–1.69
Obese (≥30 kg/m²)	1.38	0.80–2.38	1.11	0.63–1.96	1.41	0.82–2.42
BMI *by* gender (interaction)						
Underweight (<20 kg/m²) *by* female	..	.	..	.	0.38	0.15–0.95 [c]
Overweight (27–29.9 kg/m²) *by* female	..	.	..	.	0.65	0.27–1.53
Obese (≥30 kg/m²) *by* female	..	.	..	.	0.77	0.36–1.69
Leisure physical activities (>20 minutes at a time)						
>1 a week	1.0	.	..	.	1.0	.
1–3 times a month	1.11	0.65–1.89	..	.	1.08	0.76–1.54
Never	1.79	1.18–2.73 [e]	..	.	1.47	1.09–2.00 [e]
Detailed 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	2.11	0.97–4.61 [b]	1.45	0.67–3.14	1.80	1.04–3.11 [c]
Moving around, longer distance	3.64	1.97–6.71 [e]	3.39	1.93–5.95 [e]	3.56	2.34–5.40 [e]
Moving around, short distance	3.91	2.03–7.54 [e]	2.49	1.41–4.41 [e]	3.05	1.97–4.70 [e]
Standing in a fixed position	3.46	1.52–7.89 [e]	3.64	1.84–7.20 [e]	3.60	2.12–6.09 [e]
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	..	.	1.0	.	1.0	.
Fairly often	..	.	1.83	1.02–3.26 [c]	1.23	0.84–1.81
All the time	..	.	2.78	1.44–5.39 [e]	1.62	1.04–2.53 [d]
Whole body vibrations						
Never or occasionally	1.0	.	..	.	1.0	.
Fairly often	1.44	0.73–2.82	..	.	1.32	0.69–2.55
All the time	3.70	2.02–6.76 [e]	..	.	2.98	1.65–5.38 [e]
Intimidation at work						
Never	1.0	.	..	.	1.0	.
Occasionally, often, or very often	1.55	1.00–2.39 [c]	..	.	1.43	1.05–1.94 [d]
Job strain						
Low strain PD- DL+	1.0	.	1.0	.	1.0	.
Passive PD- DL-	0.51	0.30–0.89 [d]	0.89	0.49–1.61	0.71	0.47–1.06 [b]
Active PD+ DL+	0.74	0.43–1.27	0.77	0.39–1.51	0.79	0.52–1.21
High strain PD+ DL-	0.92	0.54–1.58	1.43	0.80–2.54	1.11	0.75–1.66
Psychological distress						
Low	1.0	.	1.0	.	1.0	.
Elevated	2.48	1.61–3.81 [e]	1.95	1.30–2.94 [e]	2.17	1.61–2.92 [e]

[a] Hosmer and Lemeshow goodness of fit test: P=0.820 for the model for the male population; P=0.118 for the model for the female population; P=0.234 for the model for the total population.
[b] P-value ≤0.05.
[c] P-value ≤0.01.
[d] P-value ≤0.005.
[e] P-value ≤0.001.
[f] P-value =0.013.
[g] This OR for the gender variable reflects the gender effect of workers with a healthy weight and with no preschool child at home (corresponding to the reference categories of all the variables interacting with gender); The average gender effect for the total population is significant (P-value <0.001), with female gender associated with more pain.

Table E. Risk factors associated with significant ankle/foot pain that interfered with usual activities in the previous 12 months among men, women and total population: results from the final logistic model, 1998 Quebec working population aged 18 to 65, working at least 25 hours/week. (Adj OR = adjusted odds ratio, 99% CI = 99% confidence interval)

	Men [a]		Women [a]		Total population [a]	
	OR	99% CI	OR	99% CI	OR	99% CI
Gender						
Male	..	.	..	.	1.0	.
Female					2.39	1.76–3.25 [g]
Age						
25–39 years	1.0	.	1.0	.	1.0	.
18–24 years	1.40	0.78–2.52	1.79	0.96–3.34 [b]	1.47	0.96–2.26 [b]
40–49 years	1.09	0.74–1.59	1.10	0.73–1.65	1.07	0.81–1.42
50–65 years	1.41	0.91–2.19 [b]	2.61	1.72–3.97 [e]	1.86	1.36–2.53 [e]
Household income						
Upper-middle- or higher-income quintiles	1.0	.	1.0	.	1.0	.
Very poor, poor, or lower-middle-income quintiles	1.44	1.06–1.95 [d]	1.39	0.99–2.23 [f]	1.39	1.11–1.75 [e]
Having a preschool child						
No	1.0	.	..	.	1.0	.
Yes	1.69	1.14–2.50 [e]	..	.	1.81	1.25–2.63 [e]
Having a preschool child by gender (interaction)					0.38	0.20–0.70 [e]
Body mass index,						
Healthy weight (20–26.9 kg/m^2)	1.0	.	1.0	.	1.0	.
Underweight (<20 kg/m^2)	1.87	0.96–3.63 [b]	0.65	0.37–1.14 [b]	1.91	0.99–3.71 [f]
Overweight (27–29.9 kg/m^2)	1.17	0.80–1.70	1.33	0.79–2.25	1.16	0.80–1.70
Obese (≥30 kg/m^2)	2.22	1.48–3.33 [e]	1.25	0.76–2.04	2.23	1.48–3.35 [e]
Body mass index by gender (interaction)						
Underweight (<20 kg/m^2) by female	..	.	..	.	0.34	0.14–0.80 [e]
Overweight (27–29.9 kg/m^2) by female	..	.	..	.	1.12	0.59–2.13
Obese (≥30 kg/m^2) by female	..	.	..	.	0.54	0.28–1.01 [f]
Detailed 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	1.90	0.99–3.65 [b]	1.07	0.54–2.12	1.38	0.87–2.21
Moving around, longer distance	3.66	2.25–5.96 [e]	3.47	2.15–5.58 [e]	3.44	2.48–4.77 [e]
Moving around, short distance	3.59	2.11–6.10 [e]	3.01	1.89–4.78 [e]	3.16	2.23–4.47 [e]
Standing in a fixed position	6.29	3.46–11.5 [e]	2.78	1.49–5.21 [e]	3.95	2.56–6.10 [e]
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	..	.	1.0	.	..	.
Fairly often	..	.	0.64	0.34–1.19	..	.
All the time	..	.	1.79	0.95–3.38 [b]	..	.
Repetitive hand and arm movements						
Never or occasionally	..	.	1.0	.	1.0	.
Fairly often	..	.	1.49	0.85–2.60	1.27	0.87–1.85
All the time	..	.	1.70	1.08–2.66 [d]	1.53	1.14–2.07 [e]
Whole body vibrations						
Never or occasionally	1.0	.	..	.	1.0	.
Fairly often	1.08	0.60–1.94	..	.	1.00	0.57–1.78
All the time	2.67	1.58–4.52 [e]	..	.	2.40	1.43–4.03 [e]
Intimidation at work						
Never	1.0	.	..	.	1.0	.
Occasionally, often, or very often	1.57	1.10–2.23 [e]			1.45	1.12–1.87 [e]
Job strain						
Low strain PD$^-$ DL+	1.0	.	1.0	.	1.0	.
Passive PD$^-$ DL-	1.02	0.65–1.60	0.68	0.41–1.11 [b]	0.84	0.60–1.18
Active PD+ DL+	1.18	0.74–1.88	0.99	0.58–1.68	1.07	0.75–1.52
High strain PD+ DL$^-$	1.07	0.67–1.73	1.21	0.74–1.98	1.13	0.80–1.59
Psychological distress						
Low	1.0	.	1.0	.	1.0	.
Elevated psychological distress	2.00	1.39–2.86 [e]	1.85	1.29–2.66 [e]	1.87	1.45–2.41 [e]

[a] Hosmer and Lemeshow goodness of fit test: P=0.260 for the model for the male population; P=0.500 for the model for the female population; P=0.191 for the model for the total population.

[b] P-value ≤0.05.

[c] P-value ≤0.01.

[d] P-value ≤0.005.

[e] P-value ≤0.001.

[f] P=0.012.

[g] This OR for the gender variable reflects the gender effect of workers with a healthy weight and with no preschool child at home (corresponding to the reference categories of all the variables interacting with gender); The average gender effect for the total population is significant (P-value <0.001), with female gender associated with more pain.