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Symptoms of Musculoskeletal Disorders Among Apprentice Construction Workers

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Musculoskeletal disorders (MSDs) are a major cause of work-related disability and lost-time illnesses for many occupational groups. This study determined the prevalence of musculoskeletal symptoms among young construction workers. A symptom and job factors survey was self-administered to 996 construction apprentices. Prevalence was determined by the percent of positive responses to musculoskeletal symptom questions. Odds ratios and 95 percent confidence intervals were the measures of association between prevalent musculoskeletal symptoms and demographic, leisure, and job factors and were determined by logistic regression.

The low back was the site most commonly reported for job-related musculoskeletal symptoms (54.4%), which was also the most common reason for seeking care from a physician (16.8%) and missing work (7.3%). Number of years worked in the construction trade was significantly associated with knee (p-trend $=$ 0.0009) and wrist/hand (p-trend $<$ 0.04) MSD symptoms and was suggestive of an association with low back pain (p-trend $=$ 0.05). "Working in the same position for long periods" was the job factor identified as most problematic, with 49.7 percent of all construction apprentices rating it as a moderate/major problem contributing to musculoskeletal symptoms.

Musculoskeletal symptoms are a significant problem among young construction workers at the beginning of their careers. Prevention strategies are needed early in the apprentice training program to reduce the potential disability associated with work-related musculoskeletal symptom disorders.

Keywords Disability, Occupation, Musculoskeletal, Prevalence

Musculoskeletal disorders (MSDs) are a major cause of work-related disabilities and lost-time illnesses and injuries in the United States. Nearly 8 million people (6.4% of the U.S. workforce) are employed in the construction industry[1] and the construction industry has the second highest incidence rate for reported injuries and illnesses.[2] Additionally, it has been reported that many MSDs are underreported, raising the number of cases that may actually be occurring in the workplace.[3,4]

The nature of work in the construction industry often varies in its work conditions (residential vs. commercial, weather), job sites (workers may work at multiple sites and geographical locations), and employers (workers often have multiple employers). The variable conditions inherent in construction work make it difficult to determine the association between working conditions and MSDs.

Apprentices in the construction industry are relatively young and generally have had less exposure to workplace conditions that are frequently associated with MSDs compared to experienced construction workers. The majority of studies of MSDs among construction workers have been conducted on experienced workers.[5,6] Unfortunately, the timeframe leading to the development of MSDs is not known. The purpose of this study was to assess the prevalence of MSD symptoms among construction apprentices and investigate occupational and personal factors that are associated with the symptoms.

METHODS

Apprentice construction workers were recruited from four trade unions (sheet metal workers, electricians, plumbers, operating engineers) in four states (Iowa, Illinois, Oregon, and Washington). The recruitment took place during apprentice training sessions at the respective trade unions between 1996 and 2000. Apprentices actively work in the trade while simultaneously undergoing specialized instruction in conjunction with a union training program. The training program usually consists of 80 hours per year of classroom or shop work as well as on-site instruction. The training lasts from four to five years, depending on the trade, resulting in journeyman certification.

Approximately one week prior to data collection, participants were informed of the study utilizing notices placed on bulletin boards and instructors announcing the research study in class. Construction apprentices completed a self-administered

four-page questionnaire. The questionnaire requested information on demographics, self-reported MSD symptoms, job factors (current job tasks, hours worked per week, weeks worked per year, prior job history, job activities that could contribute to job pain), and leisure-time activities. This questionnaire has been shown to have fair to good reliability.[7]

For self-reported MSD symptoms, a modification of the Standardised Nordic Questionnaire was utilized.[8] The questionnaire asked the following three questions for nine different anatomic sites (neck, shoulder, upper back, lower back, elbow, wrist/hand, hip/thigh, knee, feet): "During the last 12 months have you had a job-related ache, pain, discomfort?", "During the last 12 months have you been prevented from doing your day's work due to this condition?", and "During the last 12 months have you seen a physician (M.D., Osteopath, Chiropractor) for this condition?" For job factors, construction apprentices were asked to rate on a 0–10 scale (0 = no problem, 10 = major problem) 15 descriptions of job activities that could contribute to job-related musculoskeletal symptoms and injury. Six leisure activities (lifting weights, playing racquet sports, playing a musical instrument, sewing, doing woodwork or automobile work, and playing computer games) were assessed by the frequency of participation (never, seldom, sometimes, often, and very often). The survey took about 10 minutes to complete. Study participants provided written consent and were paid a nominal fee of $5.00. The study was approved by the University of Iowa Institutional Review Board.

Data Analyses

Prevalences for each of the nine body sites were determined by dividing the number of "yes" responses to questions regarding MSD symptoms by the total number of participants. Percentiles or means and medians were calculated for demographics, job factors, and leisure activities. T-tests and chi square tests compared covariates between "yes" and "no" respondents for the MSD symptoms and demographic factors. Job factors were dichotomized as 0–4 (no problem/some problem) or 5–10 (moderate/major problem) for bivariable and multivariable analyses. Years worked was categorized using quartile cutpoints.

Due to small numbers in some cells for leisure activities, the five categories (never, seldom, sometimes, often, and very often) were collapsed into three categories (never/seldom, sometimes, often/very often), except for the variable sewing, which was dichotomized as never or ever (i.e., never/seldom vs. sometimes/often/very often). The demographic, job factor, and leisure variables were modeled univariately with low back symptoms, wrist/hand symptoms, and knee symptoms. All univariate variables (at $p < 0.10$ significance level) were modeled multivariately for associations with prevalent low back symptoms, wrist/hand symptoms, and knee symptoms. Odds ratios (OR) and 95 percent confidence intervals (CIs) were calculated by stepwise logistic regression for multivariate modeling. All data were analyzed with Statistical Analysis Software for PC V 8.0.[9]

TABLE I
Demographics of apprentice construction workers (N = 996)

	Mean (±SD)
Age, y	27.7 (±6.2)
Sex, % male	929 (93.3)
Body mass index (kg/m^2)	26.4 (±4.3)
Education, y	13.0 (±1.5)
Years worked at current job	3.2 (±2.5)
Hours worked per week	45.1 (±8.6)
	N (%)
Trade	
Electrician	165 (16.6)
Sheet metal	136 (13.7)
Plumber	356 (35.7)
Operating engineer	339 (34.0)
Apprenticeship level	
First year	355 (35.6)
Second year	227 (22.8)
Third year	275 (27.6)
Fourth year	103 (10.4)
Fifth year	36 (3.6)

RESULTS

The demographics of the construction apprentices are presented in Table I. A total of 1175 apprentices were eligible to participate, with 996 actually participating (84.8% response rate). The mean age of all construction apprentices was 27.7 years (sd = 6.2), and females (n = 67) represented 6.7 percent of the construction apprentices. Construction apprentices had worked at their current jobs an average of 3.2 years (sd = 2.5). The majority of participants were first-year apprentices (n = 355; 35.6%).

Table II displays the 12-month period prevalence of MSD symptoms. The low back was the area with the highest prevalence of MSD symptoms (54.4%), followed by the wrist/hand (42.4%) and knee (38.4%). Slightly more than three-fourths (76.8%; 765/996) of the construction apprentices reported that they experienced work-related MSD symptoms in at least one of the nine anatomical sites, and 1.6 percent (16/996) reported experiencing work-related MSD symptoms at all nine anatomic sites (data not shown).

Almost one in six apprentices (16.8%) reported seeing a physician for low back symptoms, and 7.3 percent missed work due to low back symptoms during the previous year. After low back symptoms, construction apprentices were more likely to miss work due to wrist/hand symptoms (3.4%) and upper back symptoms (2.8%). As a percentage of only those who experienced MSD symptoms at specific sites (rather than as a percentage of all apprentices), apprentices were most likely to see a physician for upper back symptoms (34.9%), neck symptoms (31.2%), and low back symptoms (30.8%). Again,

TABLE II
Frequency of prevalent musculoskeletal disorder symptoms in apprentice construction workers (N = 996)

Anatomic site	12-month period prevalence had symptoms N (%)	12-month period prevalence missed work N (%)	12-month period prevalence saw MD N (%)
Neck	317 (31.8)	16 (1.6)	99 (9.9)
Upper back	272 (27.3)	28 (2.8)	95 (9.5)
Lower back	542 (54.4)	73 (7.3)	167 (16.8)
Shoulder	278 (27.9)	18 (1.8)	68 (6.8)
Elbows	155 (15.6)	11 (1.1)	16 (1.6)
Wrist/hand	422 (42.4)	34 (3.4)	37 (3.7)
Hip/thighs	94 (9.4)	6 (0.6)	24 (2.4)
Knees	382 (38.4)	18 (1.8)	45 (4.5)
Feet	231 (23.2)	22 (2.2)	30 (3.0)

as a percentage of only those who experienced MSD symptoms at specific sites, the greatest percentage of apprentices missed work due to low back symptoms (13.5%), followed by upper back symptoms (10.3%) and feet symptoms (9.5%).

Women reported significantly more MSD symptoms in the neck, upper back, shoulder, elbow, wrist/hand, and hip/thigh, than men, as displayed in Table III. The greatest disparity in the prevalence of MSD symptoms experienced by women compared to men was for elbow symptoms (37.3% in women vs. 14.0% in men) and hip/thigh symptoms (23.9% in women vs. 8.4% in men).

Figure 1 displays the job factors identified by construction apprentices as contributing to their work-related MSD symptoms. The job factor "working in the same position for long periods" (defined as working in the same position for long periods [standing, bent over, sitting, kneeling, etc.]) was rated highest (median = 5 on 0–10 scale) for contributing to work-related MSD symptoms. The greatest percentage (49.7%) of construction apprentices also rated "working in the same position for long periods" as a moderate/major problem ($\geq$5 on 0–10 scale).

TABLE III
Prevalent musculoskeletal disorder symptoms in apprentice construction workers, stratified by gender

Anatomic site	Females (N = 67) N (%)	Males (N = 929) N (%)	χ^2 *p*-value
Neck	33 (49.2)	284 (30.6)	0.0009
Upper back	29 (43.3)	243 (26.2)	0.0018
Shoulder	31 (46.3)	247 (26.6)	0.0002
Low back	38 (56.7)	504 (54.2)	0.49
Elbow	25 (37.3)	130 (14.0)	<0.0001
Wrist/hand	40 (59.7)	382 (41.1)	0.0011
Hip/thigh	16 (23.9)	78 (8.4)	<0.0001
Knee	31 (46.3)	351 (37.8)	0.14
Feet	19 (28.4)	212 (22.8)	0.19

"Bending or twisting the back awkwardly" (35.8%), "working in an awkward or cramped position" (32.5%), "working when hurt" (32.0%), and "reaching or working over your head or away from your body" (28.9%) were also job factors identified by a high percentage of construction apprentices as contributing to MSD symptoms.

The frequency of participation in leisure activities reported by the apprentices is presented in Table IV. Woodworking/auto maintenance was the leisure activity subjects participated in most often (32.8% for often/very often), followed by computer usage (22.3%) and lifting weights (16.1%). Apprentice construction workers were least likely to play musical instruments, sew or "play tennis, racquetball, or go bowling."

The association between prevalent low back, wrist/hand, and knee symptoms and demographic, job factor, and leisure activities are shown in Table V. There was a suggestive association between years worked in the trade and low back pain (p-trend = 0.05). No demographic variables were associated with low back symptoms, but the job factors of "bending or twisting the back awkwardly" (OR = 2.36; 95% CI = 1.63–3.44) and "working in the same position for long periods" (OR = 1.88; 95% CI = 1.32–2.67) were associated with prevalent low back pain. The leisure activity of playing a musical instrument was associated with an almost threefold increase of prevalent low back symptoms (OR = 2.97; 95% CI = 1.22–7.23).

Wrist/hand symptoms were associated with female gender (OR = 2.00; 95% CI = 1.13–3.57), years worked in the trade (p-trend = 0.04), and the job factors "repetitive tasks" (OR = 2.76; 95% CI = 1.85–4.14), "grasping small objects" (OR = 3.41; 95% CI = 2.14–6.78), and "working in the same position for long periods" (OR = 1.79; 95% CI = 1.31–2.47). An effect modification was observed between "grasping small objects" and "working near physical limits." A high proportion of subjects who rated "grasping small objects" as a moderate/major problem also rated "working near physical limits" as no/some problem. This resulted in an inverse association between "working near physical limits" and wrist/hand symptoms in the multivariate modeling (OR = 0.88; 95% CI = 0.58–1.34).

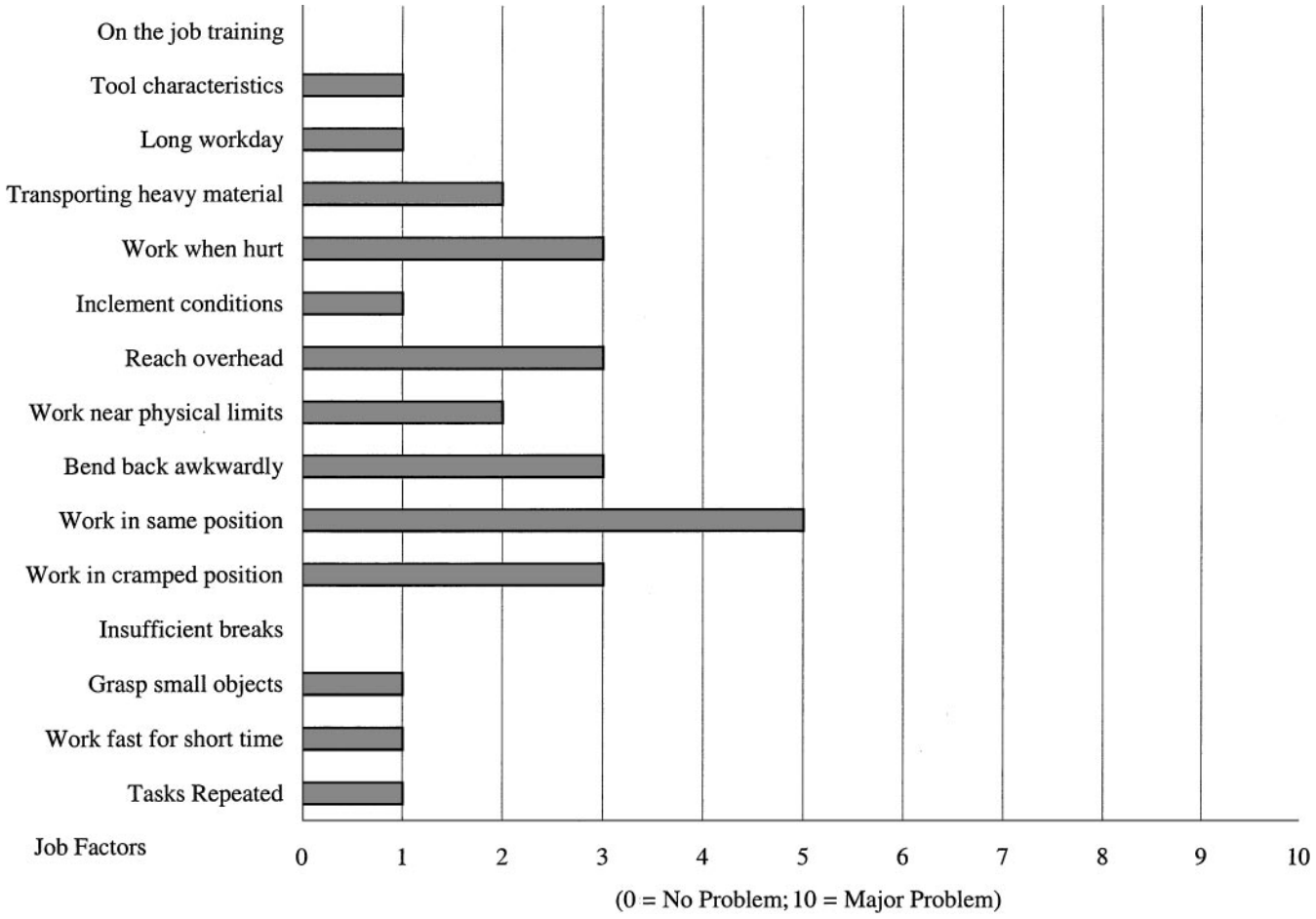

FIGURE 1
Median rating of self-reported factors contributing to work-related pain in apprentice construction workers (N = 996).

Prevalent knee symptoms were associated with years worked in the trade (p-trend = 0.0009) and the job factors "working in an awkward or cramped positions" (OR = 1.31; 95% CI = 0.93–1.84), "working in the same position for long periods" (OR = 2.11; 95% CI = 1.52–2.93), and "working in inclement conditions" (OR = 1.47; 95% CI = 1.04–2.07). The job factors for all three anatomical sites attenuated on multivariate analyses.

DISCUSSION

Symptoms of musculoskeletal disorders in construction workers are widespread and start at a relatively young age. The majority of apprentice construction workers reported MSD symptoms in at least one of nine anatomical sites during the previous year. Female workers reported a significantly higher prevalence of upper-extremity musculoskeletal symptoms (neck, shoulder, elbow, wrist/hand, and upper back) than males. A

TABLE IV
Frequency of apprentice construction workers' participation in leisure time activities

	Never/seldom N (%)	Sometimes N (%)	Often/very often N (%)	Missing data N
Weight lifting	448 (56.4)	218 (27.5)	128 (16.1)	202
Tennis, racquetball, bowling	554 (70.5)	167 (21.3)	65 (8.2)	210
Playing musical instrument	810 (90.8)	39 (5.0)	33 (4.2)	214
Sewing (embroider, knit)	755 (96.8)	18 (2.3)	7 (0.9)	216
Woodwork, auto maintenance	203 (26.0)	321 (41.2)	256 (32.8)	216
Home computer work/games	401 (51.1)	209 (26.6)	175 (22.3)	211

TABLE V
Factors associated with prevalent symptoms of musculoskeletal disorders

	Experience symptoms		Crude odds ratio	95% confidence interval	Adjusted odds ratio[A]	95% confidence interval
	Yes	No				
Low back symptoms, (N)	542	439	—	—	—	—
Years worked, (N)						
<1.5 years worked	100	108	1	—	1	—
1.5–3.0 years worked	137	135	1.10	0.76–1.57	1.06	0.69–1.62
3.0–4.0 years worked	120	87	1.49	1.01–2.20	1.29	0.81–2.03
>4.0 years worked	175	102	1.85	1.29–2.67	1.47	0.95–2.27
Trend test	—	—	—	$p = 0.0002$	—	$p = 0.05$
Work in same position,[B] (N)						
<5 Rating	210	284	1	—	1	—
≥5 Rating	332	155	2.90	2.23–3.76	1.88	1.32–2.67
Twist back awkwardly,[B] (N)						
<5 Rating	283	343	1	—	1	—
≥5 Rating	259	96	3.27	2.47–4.37	2.36	1.62–3.44
Play musical instrument, (N)						
Never/seldom	385	318	1	—	1	—
Sometimes	20	19	0.87	0.46–1.66	1.01	0.51–2.01
Often/very often	24	7	2.83	1.20–6.66	2.97	1.22–7.23
Wrist/hand symptoms, (N)	422	559	—	—	—	—
Gender, (N)						
Male	382	535	1	—	1	—
Female	40	24	2.33	1.38–3.94	2.00	1.13–3.57
Years worked, (N)						
<1.5 years worked	65	142	1	—	1	—
1.5–3.0 years worked	113	157	1.61	1.08–2.40	1.32	0.88–1.98
3.0–4.0 years worked	99	110	2.02	1.33–3.07	1.30	0.84–2.00
>4.0 years worked	139	139	2.40	1.61–3.58	1.58	1.06–2.36
Trend test	—	—	—	$p = 0.003$	—	$p = 0.04$
Repetitive tasks,[B] (N)						
<5 Rating	275	500	1	—	1	—
≥5 Rating	147	59	4.53	3.24–6.34	2.76	1.85–4.14
Grasp small objects,[B] (N)						
<5 Rating	312	518	1.00	—	1.00	—
≥5 Rating	110	41	4.45	3.03–6.55	3.81	2.14–6.78
Work in same position,[B] (N)						
<5 Rating	153	339	1	—	1	—
≥5 Rating	269	220	2.71	2.09–3.52	1.79	1.31–2.47
Work at physical limits,[B] (N)						
<5 Rating	305	460	1	—	1	—
≥5 Rating	117	99	1.78	1.32–2.42	0.88	0.58–1.34
Interaction with grasp small	375	538	—	—	1	—
Objects & work at physical limits	47	21	—	—	0.49	0.19–1.04
Knee symptoms, (N)	367	573	—	—	—	—
Years worked, (N)						
<1.5 years worked	54	152	1	—	1	—
1.5–3.0 years worked	100	172	1.66	1.07–2.49	1.52	1.01–2.29
3.0–4.0 years worked	88	120	2.13	1.30–3.25	1.65	1.08–2.54
>4.0 years worked	134	142	2.68	1.80–4.02	2.03	1.35–3.05
Trend test	—	—	—	$p < 0.0001$	—	$p = 0.0009$

(Continued on next page)

TABLE V
Factors associated with prevalent symptoms of musculoskeletal disorders *(Continued)*

	Experience symptoms		Crude odds ratio	95% confidence interval	Adjusted odds ratio[A]	95% confidence interval
	Yes	No				
Work in cramped position,[B] (N)						
<5 Rating	210	446	1	—	1	—
≥5 Rating	172	151	2.42	1.04–3.18	1.31	0.93–1.84
Work in same position,[B] (N)						
<5 Rating	132	361	1	—	1	—
≥5 Rating	250	236	2.90	2.20–3.78	2.11	1.52–2.93
Inclement work condition,[B] (N)						
<5 Rating	266	503	1	—	1	—
≥5 Rating	226	94	2.33	1.71–3.18	1.47	1.04–2.07

[A]Low back pain adjusted for work in same position, twisting the back awkwardly, playing a musical instrument, and years worked in trade; wrist pain adjusted for gender, repetitive tasks, grasp small objects, work in same position, work near physical limits, work in same position/near physical limits interaction, years worked in trade; knee pain adjusted for work in cramped position, work in same position, work in inclement conditions, years worked in trade.
[B]Rating: <5 = no/minor problem; ≥5 = moderate/major problem.

higher prevalence of upper-extremity musculoskeletal complaints among women compared to men was also found in a study by de Zwart and colleagues.[10] De Zwart et al. investigated the prevalence of musculoskeletal complaints in the general working population, as well as stratified by occupation, and reported that upper-extremity musculoskeletal complaints were not attributable to gender segregation in occupations, which had been suggested as a reason why women had higher pain prevalences.

Job Factors

Approximately half of the apprentice construction workers identified "working in the same position for long periods" as a moderate/major problem at work. The top three job factors identified as contributing to musculoskeletal problems in the present study (working in the same position for long periods, bending or twisting the back awkwardly, and working in an awkward or cramped position) were the same top three factors identified by workers in the plumbing, electrical, sheet metal and operating engineer trades in a study of 2518 journey-level construction workers.[11] Some work-related activities such as heavy lifting, bending and twisting, and forceful movements have been previously identified as risk factors for musculoskeletal pain.[12]

Leisure Activities

Activities outside of work may also influence the prevalence of musculoskeletal problems. Many construction apprentices reported that they engaged in "woodworking/auto maintenance" often or very often. These activities can be physically stressful and may contribute to the development of MSD symptoms. Activities such as auto maintenance can require intensive use of hand tools, awkward postures of the wrist, forceful muscle contractions, and repetitiveness. A large proportion of apprentice construction workers indicated that they did not participate in activities that required physical exertion associated with physical fitness (such as weight lifting, tennis, and other aerobic activities). A study by Hildebrandt showed an association between a high prevalence of low back symptoms and a sedentary lifestyle.[13] Most construction work is physically demanding and workers often indicate that they are too physically exhausted at the end of the work day to exercise.

Low Back Symptoms

The percentage of workers with MSD symptoms in the low back in this study is comparable to a finding of 50.1 percent baseline prevalence of back pain determined during a structured interview for a cohort study on construction workers.[5] An additional study using survey information from a longitudinal study of older construction workers found approximately 41 percent reported "back problems."[6] In a population-based study from the Occupational Health Supplement of the National Health Interview Survey, Behrens et al.[14] also reported that the highest prevalence of back pain due to repeated activities at work (around 10% among all workers) was in construction and heavy equipment operators, trades similar to those in the present study.

Age, gender, and body mass index were not associated with low back symptoms in this study. Age has been shown to have an inconsistent effect with low back disorders in other studies.[15] The construction apprentices were relatively young and the age range was somewhat narrow, which may have influenced the lack of association between age and low back symptoms. Playing

musical instruments often/very often compared to never was associated with low back pain. However, we did not have enough information regarding this exposure to assess it further, which may be an area of interest for future research.

Wrist/Hand Symptoms

The wrist/hand was reported as the site with the second highest prevalence of MSD symptoms. Construction work requires intensive use of the hands in the form of gripping, awkward postures, heavy lifting, and repetitive motion. These factors have been shown to be associated with several conditions such as carpal tunnel syndrome, tendonitis, and other cumulative trauma disorders.[16–18] Similar factors in the present study such as "grasping small objects," "repetitive tasks," and "working in the same position for long periods" were associated with wrist/hand symptoms. Construction workers reported the fourth highest percentage of hand discomfort in a study of the U.S. working population.[14] In a study of 308 apprentice and journeymen electricians, Hunting et al. reported that 47 percent of participants had wrist symptoms representative of cumulative trauma disorders.[19] An increasing number of years worked in the construction trade was associated with wrist/hand symptoms in the present study. This finding provides support that the construction occupation likely contributes to MSDs, especially in the absence of an association with age.

Women reported significantly more wrist/hand symptoms than men in our study. Welch and colleagues[20] reported in a survey of construction tradeswomen that ill-fitting equipment was a problem for more than half of the women. Some of the work-related MSD symptoms women experience may be related to inadequately designed hand tools and equipment.

Knee Symptoms

Knee symptoms have not been extensively studied as a work-related MSD. Construction work, however, requires heavy lifting, frequent bending, crawling, kneeling, and/or climbing, all of which put strain on the knee joint. Plumbers and pipefitters in this study reported the highest percentage (50.4%; data not shown) of knee MSD symptoms. Similar findings in the pipefitting trade were reported in a Danish review of the literature on occupation and knee disorders, which reported an increased prevalence of knee osteoarthritis with heavy physical work and kneeling.[21] Rosecrance and colleagues, in a study of 526 journey-level construction workers in the pipe trades also reported that the knee was the site with the second highest prevalence for self-reported pain.[22]

Construction workers were reported to have the highest risk for knee osteoarthrosis in a population-based study, which also found an association between osteoarthritis and heavy lifting, knee bending, and jumping.[23] The job factors of "working in an awkward or cramped position" and "work in same position for long periods" were associated with prevalent knee symptoms and may encompass knee bending, crawling, and kneeling. The association between years worked in the trade and knee symptoms was stronger with increasing years in the trade. This association implicates construction work as a contributor to MSDs.

There are several limitations in this study. Although the response rate was relatively high, we did not have any information on non-responders to assess whether there was a selection bias. This study was a cross-sectional study, so cause and effect cannot be established. The outcomes in this study were self-reported symptoms and were not clinical diagnoses. Unfortunately, there are no standardized methods for classifying self-reported musculoskeletal symptoms that correspond to specific disorders. A standardized classification scheme would be beneficial for comparison across studies.

Additionally, there were no questions regarding psychosocial assessment, which has been shown to be associated with musculoskeletal pain.[24] Lastly, the job factors were a subjective assessment of activities thought to contribute to work-related musculoskeletal disorders.

CONCLUSION

Symptoms of work-related MSDs start early in a construction worker's career and have a high prevalence among apprentice construction workers. These MSD symptoms are widespread, increase in a dose-dependent manner with increasing number of years worked in the trade, and are highly prevalent among women apprentices. The high prevalence seen in the apprentices may lead to future disability and/or attrition in the construction industry.

Reducing the prevalence and severity of work-related MSDs in the construction industry should be a primary goal for labor organizations, contractor associations, unions, and the public health community The results from this research identify areas that can be targeted by health and safety personnel to reduce musculoskeletal disorders. The low back was the site where the greatest percentage of apprentices reported pain, need for medical care, and lost worktime, so targeting preventive measures in this area should be emphasized.

Several strategies to prevent MSDs should incorporate changes in work practices. For example, supervisors should encourage workers to change postures since working in the same position for long periods was associated with musculoskeletal symptoms. Additional prevention strategies include greater use of material manual handling assists/devices, use of properly fitting hand tools that accommodate the varying sizes of individual workers, implementation of education programs that raise awareness of ergonomic principles, and encouragement by employers and supervisors to seek early medical intervention and treatment of MSDs before they become a chronic problem.

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