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Differences in the Prevalence of Musculoskeletal Symptoms Among Female and Male Custodians

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Background *The prevalence of musculoskeletal symptoms among custodians is high. We sought to compare musculoskeletal symptoms between female and male custodians and to explore how task might affect this relationship.*
Methods *A cross-sectional study was performed among 712 custodians who completed a survey assessing upper extremity, back, and lower extremity musculoskeletal symptoms and exposure to cleaning tasks. Chi-square tests and logistic regression analyses were used to test for associations between gender, cleaning tasks, and musculoskeletal symptoms.*
Results *Gender was significantly ($P < 0.05$) associated with musculoskeletal symptoms in χ^2 tests and multivariate analyses. The prevalence ratio of symptoms among women was roughly 50% higher than men, regardless of the tasks that workers performed.*
Conclusions *The prevalence of musculoskeletal symptoms differed for female and male custodians and appeared to be consistent across a range of job tasks.* Am. J. Ind. Med. 59:841–852, 2016.

KEY WORDS: sex; gender; disparities; cleaners; housekeepers; physical exposures; task

INTRODUCTION

Musculoskeletal symptoms of the upper extremity, back, and lower extremity are frequently reported among workers in many occupations, including workers in the cleaning sector such as housekeepers and custodians [Unge et al., 2007; Jorgensen et al., 2011]. The work that custodians perform is physically demanding, requiring pushing and pulling, twisted and non-neutral postures, and squatting [Unge et al., 2007]. Much of custodians' work, such as vacuuming, mopping, polishing, and buffing, entails repetition, awkward postures, and vibration, all risk factors for musculoskeletal symptoms [Woods et al., 1999; Bell and Steele, 2012]. Musculoskeletal symptoms, which are associated with impaired work ability and increased sick leave, can be burdensome for the individual, employers, and society [Mantyselka et al., 2002].

Differences in the prevalence of musculoskeletal symptoms reported by women and men have been observed across occupations; women are more likely than men to report musculoskeletal symptoms [Treaster and Burr, 2004; Wijnhoven et al., 2006]. Among custodians, one study investigating occupational injuries, which can influence musculoskeletal symptoms, reported a 24% increased risk of occupational injury for women compared to men [Alamgir and Yu, 2008]. However, no previous study has compared the prevalence of musculoskeletal symptoms between men and women working as custodians.

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Differences in the tasks performed by men and women at work may help to explain reported differences in musculoskeletal symptoms. Among cleaning workers, for example, previous studies have reported that women more often perform "light" tasks such as cleaning toilets, emptying waste baskets, and dusting, while men more often perform "heavy" tasks such as mopping or conducting repairs [Messing et al., 1998; McDiarmid et al., 2000; Mannino and Deutsch, 2007]. Tasks that are typically performed by women are often characterized by physical exposures such as high precision, a fast pace, high static loads, and excessive use of small muscles that potentially put them at high risk for developing musculoskeletal symptoms [Messing et al., 1994, 1998; Fransson-Hall et al., 1995; Messing, 1997; Josephson et al., 1999; Hooftman et al., 2005].

An alternative explanation for differences in musculoskeletal symptoms may be that men and women have different physical responses to the same task exposures. In support of this hypothesis, several previous studies have reported differences in muscular activity levels, which may affect the development of musculoskeletal symptoms, between men and women performing identical work tasks [Nordander et al., 2008; Meyland et al., 2014]. Because women on average have smaller body dimensions and lower muscle force capacity, the same task exposures can lead to higher relative workload for women compared to men [Punnett and Herbert, 2000]. In addition, work environments (e.g., surface height, tool design, equipment size) tend to be designed for men's anthropometric dimensions and strength capabilities, and this can put additional strain on women's bodies [Punnett and Bergqvist, 1999; Messing et al., 2003].

As part of the Green Cleaning and Health Study [Simcox et al., 2012; Garza et al., 2015], we sought to characterize and compare musculoskeletal symptoms between male and female custodians. Furthermore, we explored several ways in which task might affect musculoskeletal symptoms. We assessed whether male and female custodians performed different cleaning tasks, and whether differences in musculoskeletal symptoms between women and men remained after adjusting for task. We also investigated whether men and women have different physical responses to the same task exposures.

METHODS

Study Design and Population

The overall purpose of the Green Cleaning and Health Study was to identify barriers for implementing green cleaning programs, to describe use patterns, exposures, and health symptoms of traditional and disinfectant cleaning products, and to develop an intervention to improve implementation of environmentally preferable cleaning programs. Details of the study were published previously [Simcox et al., 2012; Garza et al., 2015]. Cross-sectional surveys including information on musculoskeletal

TABLE I. Distribution of Confounders Among Custodians in Study Population (Total n = 674)

Indicator	N	Mean	(%)	(Standard deviation)
Gender				
Female (reference)	382		(54)	
Male	292		(46)	
Age				
20–30	50		(7)	
31–40	91		(13)	
41–50	201		(30)	
51–60 (reference)	234		(34)	
61–70	79		(11)	
Missing	19		(3)	
Primary language				
English (reference)	356		(51)	
Spanish	155		(23)	
Polish	108		(16)	
Other language	38		(5)	
Missing	17		(3)	
Smoking status				
Non-smoker (reference)	516		(15)	
Current smoker	98		(75)	
Missing	60		(9)	
Year				
2012	310		(46)	
2014	364		(54)	
Work schedule				
Full time (reference)	601		(89)	
Part time	57		(8)	
Missing	16		(2)	
Shift				
First (reference)	452		(63)	
Second	149		(21)	
Third	93		(13)	
Type of job				
State (reference)	537		(80)	
contractor	136		(20)	
Missing	1		(<1)	
Site				
A	217		(32)	
B	229		(34)	
C	123		(18)	
D	36		(5)	
E	69		(10)	
Years working with cleaning products		13		(9)

symptoms, cleaning tasks, and participant demographics were administered anonymously to custodians, lead custodians (area supervisors), and supervising custodians recruited from five Connecticut state agencies (four universities and one university-affiliated hospital) in 2011 and in 2014. All categories of custodians surveyed (including lead and supervising custodians) performed cleaning tasks regularly. Surveys were available in English, Spanish, and Polish. All custodians working at each of the agencies were eligible to complete the survey at each time point. State-employed custodians from all five agencies and contract custodians from three of the agencies (two universities and the hospital) participated in the survey. Because the surveys were administered anonymously, there was no way to identify which participants completed the survey at both time points. The response rates ranged from 59% to 97% across the agencies, with an overall response rate of 83%. Custodians were given a small gift card incentive, which they were allowed to keep even if they did not complete the survey. The Institutional Review Board at the University of Connecticut Health Center approved the study protocol.

Musculoskeletal Symptoms

Upper extremity, back, and lower extremity musculoskeletal symptoms in the past 12 months were assessed using single item questions adapted from the Standardized Nordic Questionnaire [Kuorinka et al., 1987]. Participants were considered to have upper extremity musculoskeletal symptoms if they answered yes to the question "in the last 12 months, have you had pain or discomfort in the neck, shoulders, arms, or hands for a week or more?" Participants were considered to have back musculoskeletal symptoms if they answered yes to the question "in the last 12 months, have you had pain or discomfort in the back every day for a week or more?" Participants were considered to have lower extremity musculoskeletal symptoms if they answered yes to the question "in the last 12 months, have you had pain or discomfort in the legs or feet every day for a week or more?"

Cleaning Tasks

For this study, typical exposure to 11 cleaning tasks was assessed via the Green Cleaning and Health Survey. Workers were asked to indicate how much time (none or don't do task/less than 1 hour/1–3 hours/4–6 hours/7–8 hours) they spent doing each task on a typical day. The 11 cleaning tasks assessed included dusting, buffing floor, mopping floor, cleaning windows, vacuuming, collecting trash, sweeping, polishing stainless steel or brass, cleaning furniture, cleaning bathrooms, and cleaning toilets. To select the cleaning tasks for this study, we conducted focus groups with over 60 custodians in which we asked about cleaning tasks. Site visits in which an industrial hygienist observed custodians at work confirmed the tasks being performed by custodians [Simcox et al., 2012; Garza et al., 2015]. The cleaning tasks selected for this study have been commonly reported among custodians in previous studies as well [Krause et al., 2005; Woods and Buckle, 2006; Chang et al., 2012]. The tasks considered for this analysis were included because at least 50% of participants reported that they performed the task "less than 1 hour" or more per week. For all analyses, we combined the 4–6 and 7–8 hr categories into 4–8 hr because few participants reported performing any task for 7–8 hr. A cluster analysis (varclus procedure, Hmisc package, R-project, Austria) indicated that the 11 tasks did not group together well, so we treated each task independently in our analyses.

Gender and Confounders

Participant gender was collected in the Green Cleaning and Health Survey via the question "What is your gender?" with the response options of "male" and "female." Potential covariates and confounders including participant's shift (first/morning, second/evening, third/night), site location (A–E), year (2011 or 2014), working status (part time/less than 35 hours per week or full time/35 hours per week or greater), worker type (state worker or contract worker), age, language (English, Spanish, Polish, other), smoking status (non-smoker, current smoker), and number of years working

TABLE II. Distribution of Musculoskeletal Symptoms Among Custodians in Study Population (Total N = 674)

	Total		Male (n = 292)		Female (n = 382)		
	N	%	N	%	N	%	*P*-value
Upper extremity symptoms	278	41	91	31	187	57	<0.01
Back pain	200	30	68	23	132	40	<0.01
Lower extremity symptoms	233	35	89	30	144	44	<0.01

TABLE III. Distribution and Significance of Tasks by Gender Among Custodians in Study Population (Total N = 674)

		Male (n = 292)		Female (n = 382)		
Indicator	**Number of hours per day**	**N**	**%**	**N**	**%**	***P*-value**
Dusting	None or do not do task	44	15	44	12	0.40
	<1 hr per day	107	37	122	32	
	1–3 hr per day	113	38	172	45	
	>3 hr per day	28	10	44	12	
Buffing Floor	None or do not do task	91	29	164	43	**<0.01**
	<1 hr per day	79	28	94	25	
	1–3 hr per day	94	33	82	21	
	>3 hr per day	28	10	42	11	
Mopping Floor	None or do not do task	29	7	49	13	0.14
	<1 hr per day	42	15	75	20	
	1–3 hr per day	157	56	180	47	
	>3 hr per day	64	23	78	20	
Cleaning Windows	None or do not do task	43	12	78	20	0.29
	<1 hr per day	123	44	154	40	
	1–3 hr per day	102	36	123	32	
	>3 hr per day	24	9	27	7	
Vacuuming	None or do not do task	41	11	58	15	0.33
	<1 hr per day	83	29	123	32	
	1–3 hr per day	133	47	167	44	
	>3 hr per day	35	12	34	9	
Collecting trash	None or do not do task	19	3	41	11	**0.02**
	<1 hr per day	86	30	101	26	
	1–3 hr per day	131	46	192	50	
	>3 hr per day	56	20	48	13	
Sweeping	None or do not do task	36	12	61	13	0.32
	<1 hr per day	81	28	115	30	
	1–3 hr per day	129	44	159	42	
	>3 hr per day	46	16	47	15	
Polishing stainless steel or brass	None or do not do task	115	27	210	32	**<0.01**
	<1 hr per day	125	44	117	31	
	1–3 hr per day	41	15	46	12	
	>3 hr per day	11	4	9	2	
Cleaning furniture	None or do not do task	82	28	101	26	0.83
	<1 hr per day	114	39	143	37	
	1–3 hr per day	74	25	109	29	
	>3 hr per day	22	8	29	8	
Cleaning bathrooms	None or do not do task	84	26	89	23	0.36
	<1 hr per day	59	21	74	19	

(*Continued*)

TABLE III. (*Continued*)

Indicator	Number of hours per day	Male (n = 292)		Female (n = 382)		*P*-value
		N	%	N	%	
	1–3 hr per day	96	34	143	37	
	>3 hr per day	53	19	76	20	
Cleaning toilets	None or do not do task	45	12	66	17	0.72
	<1 hr per day	79	28	91	24	
	1–3 hr per day	113	40	146	38	
	>3 hr per day	55	20	79	21	

Bold indicates significant ($P < 0.05$) values.

in a job using cleaning products were also assessed in the Green Cleaning and Health Survey.

Statistical Analysis

We calculated descriptive statistics for the distribution of musculoskeletal symptoms, gender, and confounders in our study population. Bivariate analyses (χ^2 tests) were used to test for differences in the distribution of musculoskeletal symptoms and cleaning tasks by gender (SAS v. 9.3 Statistical Software, Cary, NC). Log-binomial regression analyses with upper extremity, back, or lower extremity musculoskeletal symptoms as dichotomous-dependent variables and cleaning tasks (categorical, reference = performs the task for <1 hr/day) and gender (dichotomous, reference = male) as independent variables were used to estimate the prevalence ratios for musculoskeletal symptoms associated with each cleaning task and gender category (IBM SPSS Statistics v. 22, Armonk, NY) . The interaction between cleaning task and gender was only included in the logistic regression models when it was significant ($P < 0.05$). All regression analyses were adjusted for shift, site, year, working status, worker type, age, language, smoking status, and number of years working in a job using cleaning products. We also performed a sensitivity analysis excluding "number of years working in a job using cleaning products" in case this variable should be considered a measure of duration of exposure instead of a confounder (although we feel that this variable is both theoretically and statistically associated with both task and musculoskeletal symptoms). Participants who were missing gender information were excluded from analysis. While we allowed for participants to have missing health symptoms and task data, if participants had missing data for a confounder variable we replaced it with the mean (continuous) or most frequent (categorical) value from the overall dataset (Table I). All confounders were treated as categorical variables except for years working in a job using cleaning products (continuous). All statistical analyses were performed using SAS v. 9.3 Statistical Software (Cary, NC). Two-tailed tests were used with a $P < 0.05$ threshold for significance.

RESULTS

A total of 674 custodians, including 596 (88%) custodians, 54 (8%) lead custodians, and 24 (4%) supervising custodians, participated in this study by completing the Green Cleaning and Health Survey in 2011 (46%) or in 2014 (54%). The majority of participants came from sites A (34%) and B (34%). Custodians in the study population were predominantly women (57%), 51–60 years old (36%), English speaking (54%), non-smokers (84%), worked full time (91%), first shift (65%), and were employed as state workers (80%) (Table I). On average, custodians in our population spent 12 years in jobs where they worked with cleaning products.

Forty-three percent, 30%, and 35% of participants reported upper extremity, back, and lower extremity musculoskeletal symptoms, respectively (Table II). We observed significant ($P < 0.01$) differences in the distribution of upper extremity, back, and lower extremity musculoskeletal symptoms by gender (Table II). Women were more likely to report all musculoskeletal symptoms.

We observed significant differences in the distribution of some cleaning task durations by gender (Table III). There were differences in the amount of time that men compared to women spent buffing floors ($P < 0.01$), collecting trash ($P = 0.02$), and polishing stainless steel or brass ($P < 0.01$). More women than men reported that they "don't do" these three tasks.

In multivariate regression analyses, gender was significantly ($P < 0.01$) and consistently associated with upper extremity, and back musculoskeletal symptoms (Tables IV–VI). Women reported a significantly higher prevalence of all musculoskeletal symptoms after adjusting for any cleaning task and for all confounders. Gender was not

TABLE IV. Multivariate Adjusted Prevalence Ratios for Upper Extremity Musculoskeletal Symptoms Associated With Each Cleaning Task and Gender Category in Regression Analyses Including Task Duration, Gender, and Confounders (Shift, Site, Year, Working Status, Worker Type, Age, Language, Smoking Status, and Number of Years Working in a Job Using Cleaning Products)

	Task (hr/day)	Odds ratio	95%CI	*P*-value	Gender	Prevalence ratio	95%CI	*P*-value
Dusting	0	0.78	[0.45, 1.34]	0.81	**Female**	**1.64**	**[1.20, 2.26]**	**<0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	1.01	[0.72, 1.41]					
	>3	0.96	[0.58, 1.58]					
Buffing floor	0	1.04	[0.71, 1.51]	0.97	**Female**	**1.66**	**[1.21, 2.29]**	**<0.01**
	<1	Reference			**Male**			
	1–3	1.04	[0.69, 1.57]					
	>3	1.16	[0.65, 2.07]					
Mopping floor	0	0.71	[0.38, 1.29]	0.22	**Female**	**1.67**	**[1.21, 2.29]**	**<0.01**
	<1	Reference			**Male**			
	1–3	1.16	[0.76, 1.75]					
	>3	1.27	[0.79, 2.03]					
Cleaning windows	0	0.71	[0.44, 1.15]	0.31	**Female**	**1.65**	**[1.20, 2.26]**	**<0.01**
	<1	Reference			**Male**			
	1–3	1.06	[0.75, 1.47]					
	>3	1.29	[0.74, 2.23]					
Vacuuming	0	0.74	[0.45, 1.23]	0.40	**Female**	**1.64**	**[1.20, 2.26]**	**<0.01**
	<1	Reference			**Male**			
	1–3	0.99	[0.70, 1.40]					
	>3	1.26	[0.76, 2.09]					
Collecting trash	0	0.83	[0.45, 1.54]	0.61	**Female**	**1.68**	**[1.22, 2.31]**	**<0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	1.13	[0.79, 1.60]					
	>3	1.23	[0.76, 2.00]					
Sweeping	0	0.72	[0.43, 1.21]	0.53	**Female**	**1.65**	**[1.20, 2.26]**	**<0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	0.98	[0.69, 1.39]					
	>3	1.10	[0.69, 1.77]					
Polishing stainless steel or brass	0	0.85	[0.61, 1.18]	0.81	**Female**	**1.68**	**[1.22, 2.31]**	**<0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	0.93	[0.59, 1.47]					
	>3	0.96	[0.40, 2.32]					
Cleaning furniture	0	0.77	[0.52, 1.14]	0.36	**Female**	**1.65**	**[1.20, 2.27]**	**<0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	0.99	[0.69, 1.43]					
	>3	1.24	[0.71, 2.17]					
Cleaning bathrooms	0	0.75	[0.46, 1.24]	0.47	**Female**	**1.65**	**[1.20, 2.27]**	**<0.01**
	<1	Reference			**Male**	**Reference**		

(*Continued*)

TABLE IV. (*Continued*)

	Task (hr/day)	Odds ratio	95%CI	*P*-value	Gender	Prevalence ratio	95%CI	*P*-value
	1–3	0.94	[0.62, 1.43]					
	>3	1.09	[0.68, 1.73]					
Cleaning toilets	0	0.63	[0.38, 1.06]	0.10	**Female**	**1.61**	**[1.17, 2.22]**	**<0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	0.96	[0.65, 1.40]					
	>3	1.24	[0.81, 1.90]					

Bold indicates significant ($P < 0.05$) values.

significantly associated with lower extremity musculoskeletal symptoms in multivariate analyses. None of the cleaning tasks were significantly associated with musculoskeletal symptoms in multivariate analyses. The interaction of cleaning task and gender was not significant in any analyses. In a sensitivity analysis excluding "number of years working in a job using cleaning products," the results did not change.

DISCUSSION

We observed a consistently higher prevalence of upper extremity, back, and lower extremity musculoskeletal symptoms of male and female custodians in our study population. We observed few differences in the distributions of cleaning tasks performed by women compared to men or gender by cleaning task interactions. The differences in musculoskeletal symptoms by gender persisted in multivariate analyses after adjusting for cleaning tasks and confounders.

Our finding of a higher prevalence of upper extremity, back, and lower extremity musculoskeletal symptoms among women compared to men within our population of custodians corresponded to the results of previous studies. For example, across occupations, women are more likely than men to report experiencing musculoskeletal symptoms [Treaster and Burr, 2004; Wijnhoven et al., 2006]. Among custodians, our results corroborate the findings of Alamgir and Yu [2008], who reported an increased risk of occupational injury, which can affect musculoskeletal symptoms, for women compared to men in the cleaning industry. We observed the largest difference (20%) in the prevalence of upper extremity symptoms between male and female custodians in our study population, which has also been reported in previous studies of other worker groups [de Zwart et al., 1997; Cassou et al., 2002].

An explanation for the discrepancy in musculoskeletal symptoms between men and women that we explored in the current study was that the tasks performed at work were differentially distributed between the genders. However, while we observed differences in the distributions of several tasks including buffing floors, collecting trash, and polishing stainless steel or brass by gender (Table III), it was unlikely that these differences could fully explain the gender differences that we observed in musculoskeletal symptoms, especially since the tasks were not associated with musculoskeletal symptoms in any of the multivariate analyses (Tables IV–VI). We observed few differences in the distributions of most of the cleaning tasks that we considered by gender (Table III). This result corroborates findings of a previous study by Heilskov-Hansen et al. [2014], who observed only minor differences in the task distribution for male and female Danish house painters. In addition, gender remained significant in the multivariate analyses after adjusting for all of the cleaning tasks (Tables IV–VI), indicating that even after adjusting for any effects of task, there were still differences in musculoskeletal symptom prevalence for women and men.

Another possible explanation for the discrepancy in musculoskeletal symptoms between men and women that we explored in the study was that women and men respond differently to the same task exposures. We evaluated this hypothesis by examining the interaction between task and gender as a predictor of musculoskeletal symptoms (Tables IV–VI). However, we observed no significant interactions between task and gender in our analyses. Therefore, it is unlikely that differences in how men and women respond to the same task explained the gender differences that we observed in musculoskeletal symptoms.

Since differences in musculoskeletal symptoms between male and female custodians persisted regardless of task, what other factors might be able to explain the differences? One possible alternative explanation could be that while the physical exposures may have been similar for men and women in our study population, their psychosocial exposures may differ. Hooftman et al. [2005] reported that for both desk and assembly workers, women reported more job demands and less job control, and Josephson et al. [1999] reported associations between high physical and psychosocial workloads in occupations dominated by

TABLE V. Multivariate Adjusted Prevalence Ratios for Back Symptoms Associated With Each Cleaning Task and Gender Category in Regression Analyses Including Task Duration, Gender, and Confounders (Shift, Site, Year, Working Status, Worker Type, Age, Language, Smoking Status, and Number of Years Working in a Job Using Cleaning Products)

	Task (hr/day)	Odds ratio	95%CI	*P*-value	Gender	Prevalence ratio	95%CI	*P*-value
Dusting	0	0.68	[0.36, 1.28]	0.66	**Female**	**1.55**	**[1.09, 2.21]**	**0.02**
	<1	Reference			**Male**	**Reference**		
	1–3	0.95	[0.65, 1.37]					
	>3	1.04	[0.61, 1.79]					
Buffing floor	0	1.00	[0.65, 1.53]	0.48	**Female**	**1.61**	**[1.13, 2.31]**	**<0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	1.29	[0.82, 2.04]					
	>3	1.41	[0.75, 2.65]					
Mopping floor	0	0.76	[0.37, 1.55]	0.15	**Female**	**1.59**	**[1.11, 2.27]**	**0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	1.36	[0.84, 2.21]					
	>3	1.49	[0.86, 2.56]					
Cleaning windows	0	0.80	[0.46, 1.39]	0.11	**Female**	**1.55**	**[1.09, 2.21]**	**0.02**
	<1	Reference			**Male**	**Reference**		
	1–3	1.40	[0.96, 2.04]					
	>3	1.52	[0.82, 2.83]					
Vacuuming	0	1.06	[0.62, 1.82]	0.96	**Female**	**1.55**	**[1.09, 2.21]**	**0.02**
	<1	Reference			**Male**	**Reference**		
	1–3	1.03	[0.70, 1.53]					
	>3	1.18	[0.66, 2.14]					
Collecting trash	0	0.73	[0.35, 1.51]	0.34	**Female**	**1.59**	**[1.11, 2.27]**	**0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	1.10	[0.74, 1.64]					
	>3	1.44	[0.84, 2.47]					
Sweeping	0	0.65	[0.36, 1.19]	0.22	**Female**	**1.56**	**[1.09, 2.23]**	**0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	0.96	[0.64, 1.43]					
	>3	1.33	[0.80, 2.24]					
Polishing stainless steel or brass	0	0.80	[0.55, 1.16]	0.69	**Female**	**1.58**	**[1.11, 2.25]**	**0.01**
	<1	Reference			**Male**	**Reference**		
	1–3	0.97	[0.59, 1.61]					
	>3	0.96	[0.33, 2.75]					
Cleaning furniture	0	0.69	[0.44, 1.09]	0.26	**Female**	**1.53**	**[1.07, 2.18]**	**0.02**
	<1	Reference			**Male**	**Reference**		
	1–3	1.04	[0.69, 1.55]					
	>3	1.21	[0.65, 2.25]					
Cleaning bathrooms	0	0.91	[0.52, 1.60]	0.20	**Female**	**1.51**	**[1.06, 2.16]**	**0.02**
	<1	Reference			**Male**	**Reference**		

(*Continued*)

TABLE V. (*Continued*)

	Task (hr/day)	Odds ratio	95%CI	*P*-value	Gender	Prevalence ratio	95%CI	*P*-value
	1–3	0.98	[0.60, 1.58]					
	>3	1.48	[0.87, 2.51]					
Cleaning toilets	0	0.63	[0.35, 1.13]	0.08	**Female**	**1.51**	**[1.06, 2.17]**	**0.02**
	<1	Reference			**Male**			
	1–3	0.89	[0.58, 1.38]					
	>3	1.33	[0.82, 2.16]					

Bold indicates significant ($P < 0.05$) values.

women. Additionally, women often receive less financial compensation and have a much higher risk of exposure to psychosocial stressors such as gender-based discrimination and sexual harassment [Gutek, 2001]. Workplace psychosocial exposures are known to be risk factors for musculoskeletal symptoms [National Research Council and Institute of Medicine, 2001]. Another explanation may be that women may have different exposures outside of work, such as a heavy domestic workload [Strazdins and Bammer, 2004]. Women are more likely than men to perform household-related tasks (cleaning, laundry, etc.) in the home/family domain which may translate into a greater daily load on the musculoskeletal system of women when paid and unpaid work demands are considered cumulatively [Messing et al., 2003; Treaster and Burr, 2004]. Finally, studies have also suggested that musculoskeletal problems in women may be due to physiological differences in the biology of women's muscles, tendons, and ligaments [Punnett and Herbert, 2000] and that women may have greater sensitivity to pain and discomfort than men [Treaster and Burr, 2004]. Unfortunately, it is a limitation of our study that we were unable to collect any information on these other factors and therefore cannot investigate their effects on our results.

It must be acknowledged as a limitation of our study that we assessed "gender" using the single question "What is your gender?" with the response options of "male" and "female." A distinction should be made between sex and gender with the term "sex" referring to biological differences between women and men based on genetics and reproductive anatomy and "gender" referring to social-cultural prescriptions for what are considered to be appropriately feminine and masculine characteristics and behaviors [West and Zimmerman, 1987; Rudman and Phelan, 2010]. However, it is unclear how our participants actually interpreted our survey question, and likely that some non-differential misclassification of gender occurred with participants responding about their sexes rather than their genders. This may have biased our results toward the null. In addition, it would have been more appropriate to assess sex in order to investigate the hypothesis that men and women responded differently to the same task exposures, since we expect the differences in their responses to be related to biological characteristics such as size and strength in this case.

Other limitations of the study must also be considered. First, we were unable to measure physical exposures during cleaning tasks in our current study and cannot draw conclusions about whether physical exposures differed by task or gender among custodians in our study population. Our results did not indicate different musculoskeletal symptom responses to the same tasks by gender, which may indicate that the physical exposures were similar for men and women. Second, it is possible that men and women differed in the accuracy of their reporting of task exposures or musculoskeletal symptoms experiences, which could have led to exposure misclassification. For instance, those reporting both symptoms and exposure at the same time point may base their assessments of job tasks on their current experience of muscle pain and related symptoms. Women in our study population may be more likely to detect or report symptoms [Gijsbers van Wijk and Kolk 1997], although some of the largest gender differences have been found in studies in which objective measures, rather than self reports, were used [Punnett and Herbert, 2000]. Third, since all data were considered cross-sectional, causality cannot be determined. Because the survey was administered to the same workplaces in 2011 and in 2014, it is possible that some custodians participated at each time point, but we could not link participants across time points because the surveys were administered anonymously. Therefore, there may be some repeated measurements that have not been considered in our analyses. However, in a sensitivity analysis stratifying our results by year, we observed similar results and trends to those reported for the pooled data. Fourth, our survey only asked questions about "typical" exposure to cleaning tasks, so we were unable to capture any information on variability in exposure across days. Fifth, to reduce the burden on our participants of having them fill out a very long questionnaire, our survey only assessed musculoskeletal symptoms using single-item questions. However, there is some evidence that

TABLE VI. Multivariate Adjusted Prevalence Ratios for Lower Extremity Musculoskeletal Symptoms Associated With Each Cleaning Task and Gender Category in Regression Analyses Including Task Duration, Gender, and Confounders (Shift, Site, Year, Working Status, Worker Type, Age, Language, Smoking Status, and Number of Years Working in a Job Using Cleaning Products)

	Task	Odds ratio	95%CI	*P*-value	Gender	Prevalence ratio	95%CI	*P*-value
Dusting	0	0.77	[0.43, 1.38]	0.47	Female	1.31	[0.94, 1.83]	0.11
	<1	Reference			Male			
	1–3	1.15	[0.80, 1.65]					
	>3	1.21	[0.73, 2.02]					
Buffing floor	0	0.99	[0.66, 1.49]	0.47	Female	1.37	[0.98, 1.92]	0.06
	<1	Reference			Male			
	1–3	1.32	[0.86, 2.02]					
	>3	1.23	[0.66, 2.28]					
Mopping Floor	0	0.71	[0.36, 1.40]	0.05	Female	1.36	[0.97, 1.89]	0.07
	<1	Reference			Male			
	1–3	1.43	[0.90, 2.26]					
	>3	1.56	[0.92, 2.63]					
Cleaning windows	0	0.78	[0.47, 1.31]	0.11	Female	1.32	[0.95, 1.84]	0.10
	<1	Reference			Male			
	1–3	1.24	[0.87, 1.77]					
	>3	1.73	[0.96, 3.11]					
Vacuuming	0	0.92	[0.55, 1.53]	0.84	Female	1.31	[0.94, 1.83]	0.11
	<1	Reference			Male			
	1–3	1.09	[0.75, 1.59]					
	>3	1.18	[0.67, 2.08					
Collecting trash	0	0.73	[0.37, 1.44]	0.18	Female	1.35	[0.97, 1.89]	0.08
	<1	Reference			Male			
	1–3	1.21	[0.83, 1.77]					
	>3	1.50	[0.90, 2.48]					
Sweeping	0	0.67	[0.39, 1.16]	0.49	Female	1.32	[0.95, 1.84]	0.10
	<1	Reference			Male	Reference		
	1–3	0.91	[0.63, 1.32]					
	>3	1.05	[0.63, 1.74]					
Polishing stainless steel or brass	0	0.76	[0.53, 1.08]	0.44	Female	1.35	[0.97, 1.88]	0.08
	<1	Reference			Male	Reference		
	1–3	1.00	[0.62, 1.60]					
	>3	0.95	[0.36, 2.54]					
Cleaning furniture	0	0.70	[0.46, 1.07]	0.07	Female	1.30	[0.93, 1.81]	0.12
	<1	Reference			Male	Reference		
	1–3	1.11	[0.76, 1.63]					
	>3	1.48	[0.83, 2.66]					
Cleaning bathrooms	0	1.07	[0.63, 1.82]	0.76	Female	1.31	[0.94, 1.82]	0.11
	<1	Reference			Male	Reference		

(*Continued*)

TABLE VI. (*Continued*)

	Task	Odds ratio	95%CI	*P*-value	Gender	Prevalence ratio	95%CI	*P*-value
	1–3	1.09	[0.70, 1.72]					
	>3	1.30	[0.78, 2.17]					
Cleaning toilets	0	0.73	[0.43, 1.24]	0.27	Female	1.30	[0.94, 1.81]	0.12
	<1	Reference			Male	Reference		
	1–3	0.99	[0.66, 1.48]					
	>3	1.26	[0.80, 2.01]					

single-question surveys for occupational disorders, including musculoskeletal disorders, may more accurately assess participants with true symptoms and exclude marginal or false-positive cases [Lenderink et al., 2012]. In addition, our outcome questions were adapted from the Standardized Nordic Questionnaire [Kuorinka et al., 1987].

We did not observe any associations between specific cleaning tasks and musculoskeletal symptoms in our analyses, even though the types of tasks that custodians perform include risk factors for musculoskeletal symptoms such as repetition, awkward postures, and vibration [Woods et al., 1999; Bell and Steele, 2012]. This may be because all custodians in our sample performed a variety of cleaning tasks throughout their workdays. Therefore, our participants may have accumulated risk for developing musculoskeletal symptoms across the different tasks that they performed rather than from specific tasks. To account for this, in our analyses we used "less than 1 hour" as our reference category to compare the prevalence of musculoskeletal symptoms to participants performing the task more frequently, and also to compare against participants who did not perform the task at all. We also performed a sensitivity analysis with "none or don't do task" as the reference and still did not see any association (data not shown). Some consideration of the related nature of the tasks may provide new insights; however, a cluster analysis indicated that the 11 tasks did not group together well, so more information would be needed to perform these analyses.

Our results indicate differences in the prevalence of musculoskeletal symptoms among female and male custodians. Prevalence ratios for musculoskeletal symptoms appear to be consistent across a range of job tasks and were roughly 50% higher for women regardless of the tasks that workers performed.

AUTHORS' CONTRIBUTIONS

JMC, MA, and JLG contributed to conception of the scientific questions, data analysis approach, performed data analysis, interpretation of results, and preparation of the manuscript. AGD contributed to interpretation of results and preparation of the manuscript. NS, SW, and JDM contributed to study conception, data collection, interpretation of results, and manuscript preparation.

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DISCLOSURE (AUTHORS)

The authors report no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

Paul Landsbergis declares that he has no competing or conflicts of interest in the review and publication decision regarding this article.

IRB APPROVAL

The Institutional Review Board at the University of Connecticut Health Center approved the study protocol.

REFERENCES

Alamgir H, Yu S. 2008. Epidemiology of occupational injury among cleaners in the healthcare sector. Occup Med (Oxford, England) 58:393–399.

Bell AF, Steele JR. 2012. Risk of musculoskeletal injury among cleaners during vacuuming. Ergonomics 55:237–247.

Cassou B, Derriennic F, Monfort C, Norton J, Touranchet A. 2002. Chronic neck and shoulder pain, age, and working conditions: Longitudinal results from a large random sample in France. Occup Environ Med 59:537–544.

Chang JH, Wu JD, Liu CY, Hsu DJ. 2012. Prevalence of musculoskeletal disorders and ergonomic assessments of cleaners. Am J Ind Med 55:593–604.

de Zwart BC, Broersen JP, Frings-Dresen MH, van Dijk FJ. 1997. Musculoskeletal complaints in The Netherlands in relation to age, gender and physically demanding work. Int Arch Occup Environ Health 70:352–360.

Fransson-Hall C, Bystrom S, Kilbom A. 1995. Self-reported physical exposure and musculoskeletal symptoms of the forearm-hand among automobile assembly-line workers. J Occup Environ Med 37:1136–1144.

Garza JL, Cavallari JM, Wakai S, Schenck P, Simcox N, Morse T, Meyer JD, Cherniack M. 2015. Traditional and environmentally preferable cleaning product exposure and health symptoms in custodians. Am J Ind Med 58:988–995.

Gijsbers van Wijk CM, Kolk AM. 1997. Sex differences in perceived health. Ned Tijdschr Geneeskd 141:283–287.

Gutek BA. 2001. Women and paid work. Psychol Women Q 25:379–393.

Heilskov-Hansen T, Svendsen SW, Frolund Thomsen J, Mikkelsen S, Hansson GA. 2014. Sex differences in task distribution and task exposures among Danish house painters: An observational study combining questionnaire data with biomechanical measurements. PLoS ONE 9:e110899.

Hooftman WE, van der Beek AJ, Bongers PM, van Mechelen W. 2005. Gender differences in self-reported physical and psychosocial exposures in jobs with both female and male workers. J Occup Environ Med 47:244–252.

Jorgensen MB, Rasmussen CD, Carneiro IG, Flyvholm MA, Olesen K, Ekner D, Sogaard K, Holtermann A. 2011. Health disparities between immigrant and Danish cleaners. Int Arch Occup Environ Health 84:665–674.

Josephson M, Pernold G, Ahlberg-Hulten G, Harenstam A, Theorell T, Vingard E, Waldenstrom M, Hjelm EW. 1999. Differences in the association between psychosocial work conditions and physical work load in female- and male-dominated occupations. MUSIC-Norrtalje Study Group. Am Ind Hyg Assoc J 60:673–678.

Krause N, Scherzer T, Rugulies R. 2005. Physical workload, work intensification, and prevalence of pain in low wage workers: Results from a participatory research project with hotel room cleaners in Las Vegas. Am J Ind Med 48:326–337.

Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, Jørgensen K. 1987. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 18:233–237.

Lenderink AF, Zoer I, van der Molen HF, Spreeuwers D, Frings-Dresen MH, van Dijk FJ. 2012. Review on the validity of self-report to assess work-related diseases. Int Arch Occup Environ Health 85:229–251.

Mannino C, Deutsch F. 2007. Changing the division of household labor: A negotiated process between partners. Sex Roles 56:309–324.

Mantyselka PT, Kumpusalo EA, Ahonen RS, Takala JK. 2002. Direct and indirect costs of managing patients with musculoskeletal pain-challenge for health care. Eur J Pain 6:141–148.

McDiarmid M, Oliver M, Ruser J, Gucer P. 2000. Male and female rate differences in carpal tunnel syndrome injuries: Personal attributes or job tasks? Environ Res 83:23–32.

Messing K. 1997. Women's occupational health: A critical review and discussion of current issues. Women Health 25:39–68.

Messing K, Chatigny C, Courville J. 1998. 'Light' and 'heavy' work in the housekeeping service of a hospital. Appl Ergon 29:451–459.

Messing K, Dumais L, Courville J, Seifert AM, Boucher M. 1994. Evaluation of exposure data from men and women with the same job title. J Occup Med 36:913–917.

Messing K, Punnett L, Bond M, Alexanderson K, Pyle J, Zahm S, Wegman D, Stock SR, de Grosbois S. 2003. Be the fairest of them all: Challenges and recommendations for the treatment of gender in occupational health research. Am J Ind Med 43:618–629.

Meyland J, Heilskov-Hansen T, Alkjaer T, Koblauch H, Mikkelsen S, Svendsen SW, Thomsen JF, Hansson GA, Simonsen EB. 2014. Sex differences in muscular load among house painters performing identical work tasks. Eur J Appl Physiol 114:1901–1911.

National Research Council NRC, Institute of Medicine IOM. 2001. Occupational stress. In: Press NA, editor. Musculoskeletal disorders and the workplace: Low back and upper extremities. Washington, D.C.: National Academy of Sciences.

Nordander C, Ohlsson K, Balogh I, Hansson GA, Axmon A, Persson R, Skerfving S. 2008. Gender differences in workers with identical repetitive industrial tasks: Exposure and musculoskeletal disorders. Int Arch Occup Environ Health 81:939–947.

Punnett L, Bergqvist U. 1999. Musculoskeletal disorders in visual display unit work: Gender and work demands. Occup Med 14:113–124, iv.

Punnett L, Herbert R. 2000. Work-related musculoskeletal disorders: Is there a gender differential, and if so, what does it mean? San Diego, CA: Academic Press. pp. 474–492.

Rudman LA, Phelan JE. 2010. The effect of priming gener roles on women's implicit gender beliefs and career aspirations. Soc Psychol 41:192–202.

Simcox N, Wakai S, Welsh L, Westinghouse C, Morse T. 2012. Transitioning from traditional to green cleaners: An analysis of custodian and manager focus groups. New Solut 22:449–471.

Strazdins L, Bammer G. 2004. Women, work and musculoskeletal health. Soc Sci Med 58:997–1005.

Treaster DE, Burr D. 2004. Gender differences in prevalence of upper extremity musculoskeletal disorders. Ergonomics 47:495–526.

Unge J, Ohlsson K, Nordander C, Hansson GA, Skerfving S, Balogh I. 2007. Differences in physical workload, psychosocial factors and musculoskeletal disorders between two groups of female hospital cleaners with two diverse organizational models. Int Arch Occup Environ Health 81:209–220.

West C, Zimmerman DH. 1987. Doing gender. Gend Soc 1:125–151.

Wijnhoven HA, de Vet HC, Picavet HS. 2006. Prevalence of musculoskeletal disorders is systematically higher in women than in men. Clin J Pain 22:717–724.

Woods V, Buckle P. 2006. Musculoskeletal ill health amongst cleaners and recommendations for work organizational change. Int J Ind Ergon 36:61–72.

Woods V, Buckle P, Haisman M. 1999. Musculoskeletal health of cleaners Sudbury, Suffold. UK: HSE Books.