Ergonomic Practices Within Patient Care Units are Associated With Musculoskeletal Pain and Limitations

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Background *With the high prevalence of musculoskeletal disorders (MSDs) for patient care unit workers, prevention efforts through ergonomic practices within units may be related to symptoms associated with typical work-related MSDs.*
Methods *We completed a cross-sectional survey of patient care workers (n = 1,572) in two large academic hospitals in order to evaluate relationships between self-reported musculoskeletal pain, work interference due to this pain, and limitations during activities of daily living (functional limitations) and with ergonomic practices and other organizational policy and practices metrics within the unit. Bivariate and multiple logistic regression analyses tested the significance of these associations.*
Results *Prevalence of self-reported musculoskeletal symptoms in the past 3 months was 74% with 53% reporting pain in the low back. 32.8% reported that this pain interfered with their work duties and 17.7% reported functional limitations in the prior week. Decreased ergonomic practices were significantly associated with reporting pain in four body areas (low back, neck/shoulder, arms, and lower extremity) in the previous 3 months, interference with work caused by this pain, symptom severity, and limitations in completing activities of daily living in the past week. Except for low back pain and work interference, these associations remained significant when psychosocial covariates such as psychological demands were included in multiple logistic regressions.*
Conclusions *Ergonomic practices appear to be associated with many of the musculoskeletal symptoms denoting their importance for prevention efforts in acute health care settings.* Am. J. Ind. Med. 55:107–116, 2012. *© 2011 Wiley Periodicals, Inc.*

KEY WORDS: musculoskeletal symptoms; health care; ergonomics; low back pain; organizational policy and practice

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INTRODUCTION

Patient Care Workers in acute care hospital settings have high rates of injury and musculoskeletal disorders [Boden et al., 2011; Rodriguez-Acosta et al., 2009]. Compared to other sectors, healthcare workers sustain the second highest number of nonfatal injuries and illnesses [Bureau of Labor Statistics, 2006, 2010]. Reports of low back pain among nurses and other patient care workers range from 30% to 60% [Lagerstrom et al., 1998; Institute of Medicine, 2001; Nelson et al., 2003; Videman et al., 2005]. Patient care workers complete physically demanding tasks as part of their daily responsibilities. These physical demands, including patient handling tasks are the major suspected physical factor associated with the musculoskeletal symptoms and disorders for both the low back and other body parts [Tullar et al., 2010].

Successful injury prevention efforts within health care have combined physical ergonomics controls, such as lifts and other patient handing technology with organizational and administrative controls [Tullar et al., 2010]. Implementation of lifts requires decisions by workers and staff to utilize these types of active controls, active in that use requires an action from the worker to actualize the protective nature of the control. Hence, policies such as "zero lift" have been studied and shown to be effective in reducing injuries when in combination with technology in the form of patient handling devices [Collins et al., 2004]. Within a large academic hospital, patient care units have a great deal of autonomy. Therefore, policy implemented surrounding ergonomic practices at the patient care unit level may vary and this variability may be associated with observed variability in injury rates.

Measuring organizational policies and practices at either a group or worker level is important to understand specific relationships with musculoskeletal injuries and disability within an organization's super-structure for both understanding the etiology and prevention efforts for work-related musculoskeletal disorders [Sauter et al., 2002; Macdonald et al., 2008]. A comprehensive set of organizational policy and practice measures has been developed as part of an ecological framework for relationships between company's corporate culture and injury and disability incidents [Habeck et al., 1998; Amick et al., 2004; Gimeno et al., 2005]. These measures contain metrics for safety diligence, ergonomic practices, disability management, safety leadership, and people oriented culture. These measures have been related to mostly disability management of musculoskeletal disorders, such as carpal tunnel syndrome [Amick et al., 2000, 2004]. In terms of ergonomic practices, the metrics measure a worker's perception of their work environment related to how the job is designed to reduce lifting and their perceptions about policies surrounding ergonomics equipment and the design of the work. To some extent these practices determine specific physical working conditions or at least the opportunity to improve the physical working conditions related to physical risk factors associated with musculoskeletal disorders.

Therefore, our overall goal is to understand associations between ergonomic practices and self-reported symptoms of musculoskeletal disorders among nurses and patient care assistants in highly variable work environments of acute health care settings of large hospitals. In a cross-sectional analysis of 1,572 patient care unit workers in two large academic hospitals, we hypothesize that a decreased ergonomic practice score is associated with an increase in reporting symptoms of musculoskeletal disorders of the low back, arms, neck and shoulder, and lower extremity as well as work interference and functional limitations associated with these symptoms.

METHODS

We completed a cross-sectional survey of patient care workers in two large academic hospitals in the metropolitan Boston area in late 2009. This survey was part of the "Be Well Work Well Study" conducted by the Harvard School of Public Health Center for Work, Health and Wellbeing. The overall goal of the "Be Well Work Well Study" is to identify relationships among worksite policies, programs and practices, and worker health and economic outcomes at the individual and unit levels. This project was approved by the applicable Institutional Review Board for protection of human subjects.

Eligible workers included those employed during 2008, who worked in patient care units under the direction of a nurse manager, worked >20 hr of employment per week or designated as a minimum 0.5 full time equivalent (FTE) in Patient Care Services, and had direct patient care responsibilities. These included registered nurses, licensed practical nurses, and patient care assistants/nursing assistants. Since the goal of the overall study is to evaluate practice at the patient care unit level, workers from those assigned to environmental services and physical medicine staff (e.g., physical therapy, occupational therapy) were not included in the selection as these workers are not assigned to specific patient care units, Ineligible workers also included those on an extended absence >12 weeks, and those deemed traveling or contract nurses.

We randomly selected 2000 eligible workers, and in October 2009 invited them via email to participate in the on-line survey. After two reminders and 4 weeks, we mailed a paper version of the survey to workers who had not yet completed the on-line survey. A second paper survey and a third email reminder were sent to all non-respondents after another 2 weeks. One month later a final email reminder was sent to all non-respondents. Eligible workers were sent a recruitment letter via e-mail containing elements of informed consent defined and approved by the Institutional Review Board for protection of human subjects. The letter informed participants that by completing the survey, they indicated consent. In addition the cover page of the questionnaire contained the same elements and statements.

Outcomes

Musculoskeletal symptoms for various body areas were assessed for the past 3 months based on the standard Nordic questionnaire for musculoskeletal symptoms [Kuorinka et al., 1987]. The body areas included low back, shoulder, neck, wrist or forearm, knee, and ankle or feet. We combined responses for the neck and shoulder into a single *neck/shoulder* area and the responses for the knees, ankle, and feet were grouped into a single *lower extremity* body area. We defined *co-morbidity* when participants reported pain in more than one body area. We defined *work interference* via the question, "In general how much did this pain interfere with your normal work?" with responses of not at all, a little bit, moderately, quite a bit, and extremely. We deemed the interferences present when the individual responded with ether moderately, quite a bit, or extremely.

Musculoskeletal symptoms and their severity were also assessed during the past week for: (i) Pain in their low back (ii) Arm, shoulder, or hand pain; (iii) Tingling (pins and needles) in their arm, shoulder, or hand; (iv) Pain in their legs or knees; and (iv) Pain in their feet. Responses were on a five point scale from "0 = none" to "4 = extreme". Responses were summed and scores of 3 (moderate level of symptom for one area, or three areas of mild symptoms) or greater were considered symptomatic in the last week.

Finally, functional limitations assessed participants' ability to do activities of daily living in the last week [Hudak et al., 1996]. The activities were heavy household chores, carry a shopping bag or brief case, recreational activities in which there is impact in the arm shoulder or hand, stand for an hour or more, reach for an object on a high shelf, put on shoes or socks, get in or out of a car, stoop or bend toward the floor, kneel or squat and use any hand held tool or equipment. The 1–5 responses were summed resulting in a scale that ranged from 10 (no difficulty on any item) to 50 (unable to do any of the 10 items without help). We defined functional limitation to be a score of 14 (mild difficulty on four items or severe difficulty on one item) or higher to capture the more severe limitation scores based on inspection of the distribution of the data (less than the top quartile).

Ergonomic Practices, Safety Practices, and People Oriented Culture

Ergonomic practices were assessed using a modified organizational policies and practices (OPPs) questionnaire, developed to address organizational context in relation to injury claims and disability management (see the appendix for the specific items from [Amick et al., 2000]). The original *ergonomic practices scale* was comprised of four items assessing perceptions about organizational practices to reduce lifting, repetitive movement, and improve workstation design and purchasing of tools equipment or furniture. We changed the original item about lifting into two items, one on lifting patients and one on lifting equipment and materials. We did not ask the repetitive motion or workstation questions but asked about the design of work; pushing and pulling; and bending reaching and stooping to be more in line with physical risk factors associated with low back and shoulder [NRC/IOM, 2001]. We also asked about the purchase of equipment. Respondents were asked to "Think about the following practices on your unit over the past year. Please tell us the extent to which you agree or disagree with each statement." The response scale for all items was a five-point scale from strongly disagree to strongly agree. Factor analysis confirmed that these six items factored together; hence, all six items were summed and divided by six providing an average response scale.

In addition to the ergonomic practices we assessed people oriented culture and safety diligence from the organizational policies and practices questionnaire. *People oriented culture scale* uses four items to assess the extent to which employees are engaged in meaningful decision making in their work unit. The original *safety diligence scale* comprised five items concerning the identification and improvement of unsafe work conditions, housekeeping, equipment maintenance, action when safety rules are broken and whether supervisors confront and correct unsafe behaviors or hazards. We did not ask the question about equipment maintenance. We did ask one item from Amick's safety leadership scale regarding the training of supervisors in job hazards and safe work hazards, with the four safety diligence questions. So our safety practices scale includes the four items from safety diligence and one from safety leadership. Again, the response for questions in both scale was a five-point scale from strongly disagree to strongly agree and all items for each scale were averaged.

Individual, Demographic, Work Organization, and Psychosocial Covariates

For individual and demographic covariates, the questionnaire assessed age, gender, body mass index (BMI from weight and height), education, smoking status, and race.

For work physical and organizational factors, the questionnaire assessed the use of patient lifting devices, physical activity on the job, type of unit, job-title, work schedule, and hours worked per week. *Use of a lifting device* was measured by a single item, "In general, when a patient needs to be moved, how often do you use a lifting device?" with five response categories from "never" to "always" as well as an option to indicate that the respondent does not lift patients. The five responses were collapsed into three levels, low (never and rarely), medium (sometimes), and high (often and always). Physical activity on the job was measured by five questions asking respondents to "estimate how much time of a typical shift you spend: sitting, standing, walking, lifting and or carrying, and pushing and pulling" [Reis et al., 2005]. The response scale was five-point, none, less than half, about half, more than half, and all, which were grouped to three categories, none and less than half, about half, and more than half and all.

The 128 patient care work units sampled were grouped into 12 *types of units* reflecting similar expected workloads: Emergency Department (ER), Operating Room (OR), Adult Medical/Surgical, Adult intensive care (ICU), step-down, Pediatric Medical/Surgical, Pediatric/Neonatal intensive care, Psychiatry, Obstetrics (OB)/Postpartum, Float Pool, Ambulatory units and Orthopedics. *Job title* was categorized as including: Assistant Nurse Manager, Clinical Nurse Specialist, Staff Nurse, Patient Care Associate, Operations Coordinator, and other. *Work schedule* or shift was also measured by self-report. W*ork hours* were self-reported for a typical week at this job.

We also measured four psychosocial scales modified from the Job Content Questionnaire [Karasek and Theorell, 1990; Karasek et al., 1998; Landsbergis et al., 2002], psychological demands, decision latitude, supervisor support, and co-worker support. The *psychological demands* consisted of five items. The scale's score was a weighted sum of the responses with a low to high demand range of 12–48. *Decision latitude* was as a weighted sum of decision authority (three items) and skill discretion (six items). *Coworker support* was assessed using two items whose five points responses were summed providing a 2–10 scale score. Similarly, *supervisor support* was measured using three items, the summed responses providing a 3–15 scale score.

Statistical Analyses

To explore the bivariate associations of outcome measures with the ergonomic practices and the other safety practices and people orientated culture measures and continuous covariates, we used *t*-test comparison of means. For the categorical covariates, we used cross classification and the Chi-square test of homogeneity. For each outcome, we then computed a multiple logistic regression analysis including all the measures that were bivariately associated with the outcome at $P < 0.2$. From this first multiple regression model we identified a final set of covariates as any covariate that had a significant ($P < 0.05$) association with any of the eight outcomes. We then calculated a final multiple regression logistic model for each outcome variables using this final and consistent set of covariates across the eight outcomes without (model 1) and with (model 2) the identified psychosocial covariate scales, which have been previously associated with musculoskeletal pain and disability in nursing staff (e.g., [Lipscomb et al., 2002; Mehrdad et al., 2010]). Since we are testing relationships for ergonomic practices it was forced into the final regression models. Since many previous studies have previously reported positive associations with safety diligences and people oriented culture for disability management (e.g. [Amick et al., 2000]), these two scales were also forced into the final regression models. All analyses were carried out using SAS statistical software, version 9.2 (SAS Institute, Inc. Cary, NC).

RESULTS

A total of 1,572 workers initiated completion of the survey on line. Of those 1,399 (89%) completed at least 50% of the survey items and met our definition of survey completion. An additional 173 workers returned a completed mailed version of the survey. The total number of completed surveys is 1,572 for a response rate of 79%. Of the 1,572 respondents, 90% were female, with a mean age of 41.4 years, and a mean BMI of 26.3 kg/m^2 (Table I). Most were of non-Hispanic white ethnicity, worked something other than a regular day shift and worked more than 35 hr in a typical week. Most also estimated that they stood or walked (respectively) more than half of a typical shift. On average the respondents were neutral (neither disagree or agreed = 3) about ergonomic practices and were slightly positive about safety practices and people oriented culture (Table I).

Seventy-four percent of workers reported pain in one or multiple areas of their body for the past 3 months (Table II). The prevalence of self-reported pain in the four body areas during the previous 3 months ranged from 11% for the Arms to 53% for the low back (Fig. 1). Just below half of the sample (n = 730, 46.6%) reported pain in more than one of the four areas and just under a third (n = 516, 32.8%) reported that this pain had interfered moderately or greater with their work. In the past week, 630 (40.7%) respondents reported pain severity score above the threshold level of 3. 277 respondents (17.7%)

TABLE I. Individual Characteristics of the Patient Care Unit Workers Surveyed (n = 1572)

Individual characteristics	**N**	**%**
Gender		
Male	143	9.5
Female	1,369	90.5
Race/Ethnicity		
Hispanic	65	4.3
White, non-Hispanic	1,185	79.1
Black, non-Hispanic	159	10.6
Other	89	5.9
Education		
Grade 12/GED or less	78	5.2
1–3 years of college	360	23.9
Baccalaureate degree	803	53.4
Graduate degree	264	17.5
	Mean	**SD**
Age (years)	41.4	11.7
BMI (kg/m^2)	26.3	5.3
Organizational practices and culture		
Ergonomic Practices Scale (1–5)	3.1	0.8
Safety Practices Scale (1–5)	3.7	0.7
People Oriented Culture Scale (1–5)	3.6	0.8
Psychosocial factors		
Psychological demands (12–48)	37.5	5.5
Decision latitude (24–96)	74.8	10.3
Supervisor support (3–15)	10.6	3.0
Coworker support (2–10)	8.0	1.5
	N	**%**
Work organization		
Type of unit		
Emergency room (ER)	86	5.5
Operating room (OR)	158	10.1
Adult medical surgery	542	34.5
Adult ICU	196	12.5
Stepdown	82	5.2
Pediatric medical surgery	20	1.3
Pediatric ICU and Neonatal ICU	66	4.2
Psychiatry	20	1.3
OB-Postpartum	130	8.3
Float Pool	66	4.2
Ambulatory/Consultation/Education	165	10.5
Orthopedics	41	2.6
Job title		
Staff Nurse	1,103	70.5
Patient Care Associate (PCA)	127	8.1
Other	335	21.4
Hours Worked per Week		
<29 hr	347	22.2

(*Continued*)

TABLE I. (*Continued*)

	N		**%**
30–34	188		12.0
35–39	453		28.9
40–44	508		32.4
45 or more	70		4.5
Use a lift			
Low	545		40.9
Medium	386		29.0
High	402		30.2
	N (%)	**N (%)**	**N (%)**
	None/<Half	**About half**	**>Half/All**
Physical activity at work			
Time sitting	1,231 (81.3)	138 (9.1)	146 (9.6)
Standing	282 (18.5)	229 (15.0)	1,012 (66.4)
Walking	305 (19.9)	251 (16.4)	977 (63.7)
Lifting/Carrying	943 (61.7)	288 (18.8)	298 (19.5)
Push/Pulling	945 (62.1)	278 (18.3)	299 (19.7)

reported difficulty in completing activities of daily living and were classified as having a functional limitation.

Based on the bivariate analysis, the ergonomic practices scores were significantly lower in participants who reported pain and limitation outcomes compared to those who did not (Table III). Similarly, scores for both the safety practices and the people oriented culture scales were significantly smaller in respondents who reported pain and limitation outcomes than in those who did not (Table III).

In the multiple logistic regression analyses without the psychosocial covariates (model 1) higher ergonomic practices were significantly associated with lower reporting for all symptom and limitation outcomes (Table IV). While there were odds ratios indicating that better safety

TABLE II. The Primary Outcome Measures of the Patient Care Unit Workers Surveyed

	N	**%**
Number of body parts with pain during the last 3 months		
None	414	26.4
One	424	27.0
Two	431	27.5
Three	239	15.2
Four	60	3.8
Pain moderately to extremely interfered with work in the past 3 months	516	32.8
Pain severity > 3 in the past week	630	40.7
Functional limitations for activities of daily living > 14	277	17.7

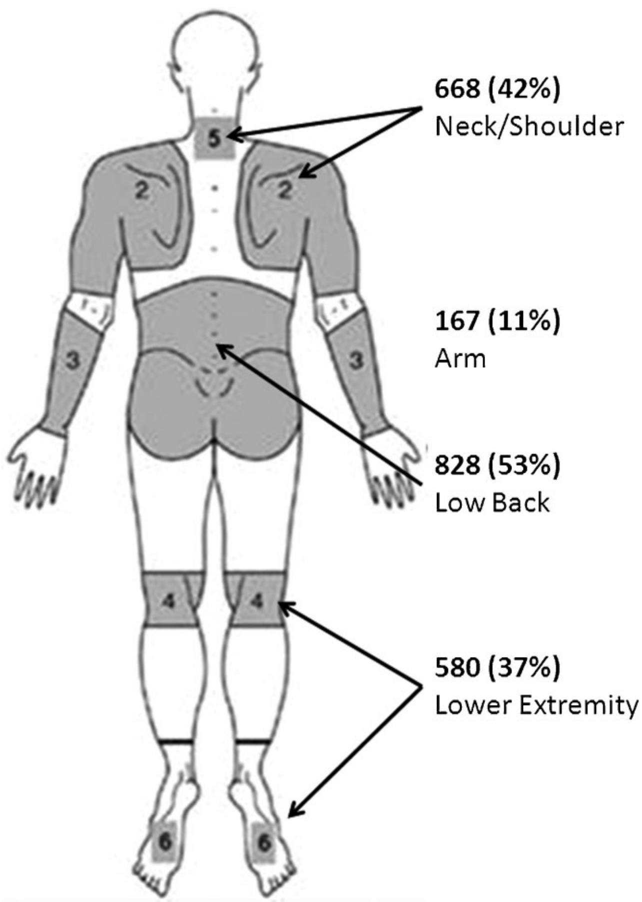

FIGURE 1. Prevalence of self-reported pain occurring in the past 3 months for the four body areas.

practices were associated with reporting fewer symptoms, none of these associates were statistically significant. Higher perception of people oriented culture scale was significantly associated with reporting lower work interference, functional limitations, and the co-morbidity outcomes.

With the addition of the psychosocial factors to the multiple logistic regression as covariates (model 2) ergonomic practices remained significantly associated with all symptom and limitation outcomes except for low back pain ($P = 0.18$) and work interference ($P = 0.08$). People oriented culture scale remained significantly associated only with work interference with the addition of the psychosocial factors.

DISCUSSION

Our goal was to understand associations between workers' perception of ergonomic practices and self-reported symptoms of musculoskeletal disorders among patient care unit workers in two large academic hospitals, with the specific hypothesis that an increased ergonomic practice score has a protective association with musculoskeletal symptoms and limitations. All of our bivariate analysis and most of the multiple logistic regression analysis support this hypothesis. Increased scores of ergonomic practices were associated with lower odds of reporting musculoskeletal pain through the four body areas, low back, neck/shoulder, arms, and lower extremity, in the past 3 months, as well as pain severity and functional limitations in the past week in both bivariate and multiple logistic regression analyses.

Overall, our results indicate that indeed the workers' perceptions about their unit's ergonomic practices are associated with self-reported musculoskeletal symptoms. The ergonomic practices scale asks workers how well work within their unit is designed to reduce lifting, pushing/pulling, and bending, reaching, and stooping, all of which are specific risk factors for musculoskeletal disorders [NRC/IOM, 2001]. These findings may suggest that workers in units with poor ergonomic practices may be at increased risk for musculoskeletal symptoms—across a range of body parts, for multiple parts of the body, and for higher severity of the pain levels. It is also possible that this association may be due to increased sensitivity of workers in pain noting specific ergonomic issues, that is, they may perceive their work environment differently than workers without pain. To those without pain, ergonomic practices may be perceived as acceptable. Those in pain can still benefit from ergonomic interventions and often secondary prevention efforts include as strong an emphasis on ergonomic practices and interventions as do primary prevention efforts [Snook 2004]. Nonetheless, the associations indicate that these practices are important and support prevention efforts that incorporate employee involvements, such as participatory approaches [Wilson, 1995; Hignett et al., 2005].

The ergonomic practice scale, however, was not significantly associated with low back pain and work-interference in the multiple regression analysis that included psychosocial factors such as psychosocial demands and supervisor support (model 2 in Table III). Studies have reported associations between psychosocial factors and low back pain in patient care workers (e.g. [Lipscomb et al., 2002; Mehrdad et al., 2010]); however, the relationships are complex and variable [van den Heuvel et al., 2004]. The psychological demands scale used in our questionnaire may capture some of the general physical demands of a job that are not captured by the specific ergonomic practice scale questions. The demands scale contains the questions, ''my job requires me to work very hard'' and ''I am not asked to do an excessive amount of work'', both of which have general cognitive and physical constructs that may capture the identified physical risk factor of heavy physical work for low back pain [NRC/

TABLE III. Mean and (SD) Values From the Bivariate Analysis for the Organizational Practice and Culture Measures and the Musculoskeletal Pain and Limitation Outcomes

	Yes	No	*P*-value
Low back pain			
Ergonomic practices	3.0 (0.8)	3.3 (0.8)	<0.0001
Safety practices	3.7 (0.7)	3.8 (0.7)	<0.0001
People oriented culture	3.6 (0.7)	3.7 (0.8)	0.0024
Neck and shoulder pain			
Ergonomic practices	3.0 (0.8)	3.2 (0.8)	<0.0001
Safety practices	3.6 (0.7)	3.8 (0.6)	<0.0001
People oriented culture	3.5 (0.7)	3.7 (0.8)	0.0052
Arm pain			
Ergonomic practices	2.9 (0.8)	3.2 (0.8)	<0.0001
Safety practices	3.6 (0.7)	3.8 (0.7)	0.0068
People oriented culture	3.4 (0.8)	3.6 (0.7)	<0.0001
Lower extremity pain			
Ergonomic practices	3.0 (0.8)	3.3 (0.8)	<0.0001
Safety practices	3.6 (0.7)	3.8 (0.6)	<0.0001
People oriented culture	3.5 (0.8)	3.7 (0.7)	0.0010
Co-morbidity			
Ergonomic practices	3.0 (0.8)	3.3 (0.8)	<0.0001
Safety practices	3.7 (0.7)	3.8 (0.6)	<0.0001
People oriented culture	3.5 (0.8)	3.7 (0.7)	<0.0001
Work interference			
Ergonomic practices	2.9 (0.8)	3.2 (0.8)	<0.0001
Safety practices	3.6 (0.7)	3.8 (0.7)	<0.0001
People oriented culture	3.4 (0.8)	3.7 (0.7)	<0.0001
Pain severity			
Ergonomic practices	2.9 (0.8)	3.3 (0.8)	<0.0001
Safety practices	3.6 (0.7)	3.8 (0.6)	<0.0001
People oriented culture	3.5 (0.8)	3.7 (0.7)	<0.0001
Functional limitation			
Ergonomic practices	2.9 (0.9)	3.2 (0.8)	<0.0001
Safety practices	3.5 (0.7)	3.8 (0.7)	<0.0001
People oriented culture	3.4 (0.8)	3.7 (0.7)	<0.0001

IOM, 2001]. Heavy physical work may not been identified for other body parts explaining why the association with the ergonomic practice scale remains significant for the other outcomes when the psychosocial demands scale is added to the model. A second factor may be that the activities associated with low back pain for patient care unit staff, mainly patient handling may not be perceived to be designed ergonomically in light of the job demands and the social support factors. Since, the original ergonomic practice scale was developed for manufacturing; hence, it may fail when respondents feel the question is not framed well for their work, such as the physical demands of a patient care worker. The ergonomic practice scale may better capture other types of work not involving patient handling, such as computer and office and hence why many of the other body parts were still associated strongly with ergonomic practices in the multiple logistic regression analyses with the psychosocial factors.

The people oriented scale was associated with the co-morbidity, work interference and functional limitations outcomes in multiple logistic regression without the psychosocial factors, which follows the intent of the organizational policies and practices scales to be a comprehensive scale for work-disability management [Amick et al., 2000]. Compared to the purely pain measures, work-interference and functional limitations outcomes include a component of disability—not being able to complete either work tasks or activities of daily living due to the pain. Only the association with work-interference remained when the psychosocial factors including

TABLE IV. Adjusted Odds Ratios per Unit of Change for Organizational Practice and Culture Measures (1–5, Scale) From the Multiple Logistic Regression Models

	Model 1[a]			Model 2[b]		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Low back pain						
Ergonomic practices	**0.81**	**0.69–0.96**	**0.01**	0.89	0.75–1.06	0.18
Safety practices	0.95	0.76–1.19	0.65	1.07	0.84–1.35	0.60
People oriented culture	0.83	0.69–1.00	0.05	0.99	0.80–1.22	0.89
Neck and shoulder pain						
Ergonomic practices	**0.76**	**0.64–0.89**	**0.001**	**0.79**	**0.67–0.94**	**0.01**
Safety practices	0.85	0.70–1.09	0.23	0.91	0.72–1.16	0.45
People oriented culture	0.95	0.79–1.14	0.60	1.02	0.82–1.26	0.88
Arm pain						
Ergonomic practices	**0.65**	**0.50–0.84**	**0.001**	**0.68**	**0.52–0.90**	**0.0057**
Safety practices	1.10	0.78–1.55	0.58	1.12	0.78–1.60	0.5466
People oriented culture	0.78	0.59–1.03	0.80	0.78	0.56–1.07	0.1204
Lower extremity pain						
Ergonomic practices	**0.76**	**0.64–0.90**	**0.002**	**0.78**	**0.66–0.94**	**0.0070**
Safety practices	0.86	0.69–1.00	0.21	0.91	0.71–1.16	0.43
People oriented culture	0.92	0.76–1.11	0.39	1.01	0.81–1.25	0.93
Co-morbidity						
Ergonomic practices	**0.66**	**0.56–0.78**	**<0.0001**	**0.70**	**0.59–0.83**	**<0.0001**
Safety practices	1.00	0.80–1.25	0.99	1.12	0.88–1.42	0.36
People oriented culture	**0.82**	**0.68–0.99**	**0.04**	0.96	0.78–1.18	0.69
Work interference						
Ergonomic practices	**0.75**	**0.64–0.89**	**0.001**	0.85	0.71–1.02	0.08
Safety practices	0.95	0.75–1.21	0.69	1.08	0.84–1.39	0.54
People oriented culture	**0.68**	**0.56–0.83**	**0.0001**	**0.78**	**0.62–0.97**	**0.02**
Pain severity						
Ergonomic practices	**0.64**	**0.54–0.76**	**<0.0001**	**0.69**	**0.57–0.82**	**<0.0001**
Safety practices	0.84	0.67–1.06	0.13	0.97	0.75–1.24	0.78
People oriented culture	0.89	0.74–1.07	0.22	1.10	0.89–1.37	0.38
Functional limitation						
Ergonomic practices	**0.67**	**0.53–0.83**	**0.0004**	**0.72**	**0.57–0.91**	**0.006**
Safety practices	0.89	0.66–1.19	0.42	0.94	0.69–1.29	0.71
People oriented culture	**0.77**	**0.66–0.98**	**0.03**	0.93	0.71–1.22	0.59

Bolded values are statistically significant at $P < 0.05$.
[a]Model 1 was adjusted for age, race, BMI, type of unit, job title, hours worked, and time sitting.
[b]Model 2 adjusted for covariates in model 1 and for psychosocial factors: demands, supervisor support, and co-worker support.

supervisor and coworker support scales, which may be due to some similarity in the people oriented culture and the co-worker and supervisor support scales. The people oriented culture scale includes assessing "working relationships are cooperative" and "communications is open and employees feel free to voice concerns and make suggestions."

The safety practice scales did not demonstrate any significant associations with the outcomes in the multiple logistic regressions, which may be due to the nature of outcomes being pain and disability rather than acute injuries more often associated with safety programs [Mark et al., 2007]. The safety practice scale has similar items in typical safety climate scales, which too have not been related to low back injuries in hospital nurses [Mark et al., 2007]. The organizational policies and practices scales were developed to capture factors related to disability management due to a range of causes including acute injuries and musculoskeletal disorders [Habeck et al., 1998]. Our study here has focused on symptoms of musculoskeletal disorders; hence, the safety scale may have better associations when the outcomes include acute injuries. In addition, the workers provided a higher safety scale than the ergonomic scales, which may indicate that current safety programs are more effective than current ergonomic practices.

The practice and culture scales were developed for examining injury incidence, disability, and return to work in a wide range of industries based on the conceptual model described by Amick et al. [2000]. Amick et al. observed that better ergonomic practices and people oriented culture were associated with the 6-month post carpal tunnel release surgery return to work status. Often these scales have been used to examine different organizational factors with disability management [Ossmann et al., 2005; Westmorland et al., 2005; Williams et al., 2005; Williams et al., 2007]. To the best of our knowledge, these scales have not been associated with reported musculoskeletal pain and functional limitations before. Musculoskeletal pain may be a subset of all causes of injury-related work-disability and hence why some of the metrics, such as safety practices scale, which may be more related to acute injury, have non-significant associations with these pain outcomes. These data suggest that these organizational factors affect a continuum of worker outcomes that includes pain (shown here) to return to work (disability management) and hence demonstrate a potential for broader impact of ergonomics on prevention in this cohort.

As noted, the associations between the organizational practice and culture scales changed when the psychosocial factors were included in the multiple logistic regression analyses. As described above, the psychosocial factors have some overlap with the practice and culture scales. In addition, the psychosocial scales may be more comprehensive measures of the work environment. For example, the demands scale was developed to capture specific cognitive demands of a job across many different types of industries and jobs [Karasek and Theorell, 1990; Karasek et al., 1998]. While comprehensive, using psychosocial factors to inform intervention has proved to be difficult [Hannan et al., 2005; Bourbonnais et al., 2006]. Because, the concepts of the organizational practices are operational factors that can be implemented in a work place. the organizational practices scales provide opportunities for organizations to improve and develop prevention programs.

These findings rely on a cross-sectional survey; as with any cross-sectional assessment, it is not possible to determine the temporal sequence in these relationships, and we therefore do not infer causality. Data were collected from two academic teaching hospitals in the greater Boston area; we acknowledge that findings from this setting may not be generalized to all other patient care settings. Findings reported here are based on self-reports from the survey, and accordingly are subject to recall and social-desirability bias. Additionally, while we controlled for workload by grouping similar units, we recognize that work on patient care units is highly variable and unknown confounders or work characteristics may impact the outcomes. Despite these limitations, it is important to note the high response rate to this survey (79%), our reliance on measures previously tested in prior literature, and the use of multiple indicators of work experiences.

In conclusion, these findings suggest the importance of having clear ergonomic practices within a hospital may be important part of an MSD intervention program in the acute care work environment. While causality has not been determined further studies investigating these factors are warranted and will provide the evidence needed for adoptions of these types of practices within the healthcare sector.

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Appendix

The original OPP Ergonomic Practices Items [Amick et al., 2000].

- Jobs are designed to reduce heavy lifting.
- Jobs are designed to reduce repetitive movement.
- Ergonomic strategies are used to improve workstation design.
- Ergonomic factors are considered in purchasing new tools, equipment, or furniture.

The modified Ergonomic Practices Questions.

- Work is designed to reduce patient lifting.
- Work is designed to reduce lifting heavy equipment.
- Ergonomic strategies are used to improve the design of work.
- Ergonomic factors are considered in purchasing new tools, equipment, or furniture.
- Work is designed to reduce pushing and pulling.
- Work is designed to reduce bending, reaching, and stooping.