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# Perceived Physical Demands and Reported Musculoskeletal Problems in Registered Nurses

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**Background:** Nursing is physically demanding, and nurses have higher rates of musculoskeletal disorders (MSDs) than most other occupational groups. The physical demands of nursing may lead some nurses to leave the profession, contributing to the shortage of registered nurses in many workplaces that is a major concern today. As a first step toward reducing MSDs and their consequences, this study was designed to examine the relationship between perceived physical demands and reported neck, shoulder, and back MSDs in nurses.

**Methods:** Data were collected anonymously from 1163 randomly selected working nurses (74% response rate) using a cross-sectional survey. The 12-item survey scale (internal reliability coefficient=0.89), rated perceived physical demands such as force, awkward postures, and heavy lifting. Nurses with a presumed MSD case reported relevant past-year symptoms in the neck, shoulder, and/or back lasting  $\geq 1$  weeks, or at least monthly, with moderate or more pain, on average.

**Results:** Moderate and high perceived physical demands were significantly associated with reported neck, shoulder, and back MSD cases, even after adjustments for demographic and lifestyle-related covariates. Adjusted odds ratios for highly demanding work (vs low) ranged from 4.98 to 6.13 depending on body site. When analyses were restricted to staff nurses only, the odds ranged from 9.05 to 11.99.

**Conclusions:** Perceived physical demands are associated with reported MSD in registered nurses, and the association is stronger in staff nurses. (Am J Prev Med 2003;24(3):270-275) © 2003 American Journal of Preventive Medicine

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## Introduction

Recent data indicate that nurses are at high risk for work-related musculoskeletal disorders (MSDs).<sup>1-6</sup> In 1999, the rate of injuries in nursing and personal care facilities ranked second (incidence rate 13.8/100 workers) and the rate in hospitals was sixth among all industries (8.4/100 workers).<sup>1</sup> Low back pain/injury is the most frequent MSD in nurses, with a past-year prevalence of 30% to 60%,<sup>2-5</sup> although studies have also reported neck problems in 30% to 48% of nurses and shoulder problems in 43% to 53%.<sup>2,3,6</sup> Several studies have indicated that MSD may contribute to nurse turnover. For example, Owen<sup>7</sup> found that 20% of nurses had changed jobs at least once due to an MSD problem. In a survey of over 43,000 nurses in five countries, 17% to 39% reported

that they planned to leave their job in the next year due to the physical and psychological demands of the profession.<sup>8</sup> These findings are especially disturbing given the current shortage of nurses and the increasing need for nursing care projected over the next decade.<sup>9</sup>

Nursing work is physically demanding<sup>10,11</sup>; bending, twisting, and other manual handling have been implicated in nurses' back injuries.<sup>5</sup> In one study, nurses and nursing aides were found to be at particular risk of back injury during patient transfers, which require sudden movements in non-neutral postures.<sup>12</sup> Patient transfers also require flexion and rotation, increasing the risk of injury due to a combination of compression, rotation, and shear forces.<sup>13-15</sup> Hoogendoorn et al.,<sup>16</sup> using video observations and questionnaires in a 3-year study of a variety of healthcare workers, found that extreme flexion and frequent heavy lifting, as experienced by many nurses in direct patient care, had a particularly great impact on workers' low back pain.

Fewer studies have examined physical demands in relation to neck and shoulder MSDs. One study, using the direct observation method of the Ovako Working posture Analysis System (OWAS), found that operating room instrumentation nurses, who were required to

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maintain tension on instruments in awkward postures, had substantial musculoskeletal stress, especially of the head, neck, and back.<sup>10</sup> In another study using OWAS, harmful postures were observed in orthopedic and urology nurses during a substantial amount of the day, especially during patient handling.<sup>17</sup>

Engels et al.<sup>2</sup> found that lifting and stooping were significantly associated with arm and neck complaints. Heavy lifting and actions with the arms above shoulder height have also been associated with shoulder pain or injury in other occupational groups.<sup>18,19</sup> While there are some data available, most of the studies conducted about nurses examined only a few physical demands; others used one or two items or job category as a proxy for physical exposure.

According to Burdorf and Van der Beek,<sup>20</sup> inadequate measurement of physical demands (due to inadequate numbers and types of items) limits the ability to correctly classify a job as high effort, leading to underestimates of the importance of physical demands in relation to MSDs. Thus, the relationship of physical demands to MSD in registered nurses needs to be further clarified, especially for the neck and shoulders, where there is limited information available. Therefore, this study examined the relationship of perceived physical demands to reported neck, shoulder, and back MSDs in registered nurses, taking into consideration the impact of psychological demands and other potentially confounding variables. Because registered nurses work in a variety of settings, the relationships were examined by nursing workplace and position.

## Methods

### Design and Sample

This study was conducted using a cross-sectional survey design. Data were collected via anonymous mailed survey, using contents and procedures recommended by Dillman<sup>21</sup> and Heberlein and Baumgartner.<sup>22</sup> A random sample of 2000 actively licensed registered nurses was selected from two U.S. state registries (1000 per state); of those, 67 were ineligible to participate due to death, incorrect mailing information (e.g., invalid location), or lack of a forwarding address, leaving 1933 in the sample.

Surveys were mailed to homes from October 1999 to February 2000. The eight-page survey instrument covered the following items: neck, shoulder, and back MSD problems; physical demands; job characteristics; and health and well-being. All items were assessed for the current job, with reported MSD restricted to the past year. Six contacts were made by first-class mail, including an introductory letter, three surveys (with the first copy including \$1.00 and a mechanical pencil to promote completion), and two reminder postcards.

Since the survey participants were anonymous, those surveyed had the opportunity to be deleted from further mailings by returning a postcard indicating participation status (completed

the survey or refused to participate) to the study office. Completed surveys were returned to a different location.

Of the 1933 registered nurses contacted, 1428 (74%) responded; 68 declined to participate using the return postcard. The analysis was restricted to the 1163 respondents who reported working as nurses within the past year, since only those nurses completed information on working conditions. Respondents were also required to have been in their current job for at least 1 year. Registered nurses reporting a non-work-related injury/accident up to 3 months before the onset of symptoms were excluded from the analysis. The mean age of participants was 45 years. Most were female (94%); Caucasian (82%); married (71%); employed as staff/general duty nurses (67.5%); and working in hospitals (57%). Half were college graduates.

### Measurement of Variables

Reported MSD cases were examined using items from the Nordic questionnaire of musculoskeletal symptoms<sup>23</sup> and including pictures of the affected body region. The operational definition was having a relevant symptom in the past year (pain, numbness, tingling, aching, stiffness, or burning) that lasted  $\geq 1$  week, or occurred at least monthly, with at least moderate pain on average (based on a 5-point pain scale).<sup>24</sup> Pain descriptors provided were "none/no pain," "mild/minimal," "moderate," "severe," and "worst pain ever in my life."<sup>25</sup> As noted earlier, non-work-related injuries were excluded. The operational definition for the MSD case was developed by a team of medical and ergonomic experts, and tested and validated in research conducted by the National Institute for Occupational Safety and Health.<sup>23</sup>

Nurses meeting the criteria for a reported MSD case were compared to nurses completely asymptomatic for neck, shoulder, and back MSD problems, since those who are asymptomatic for one body site (such as a shoulder MSD) can have another MSD (such as back) and, thus, not constitute a valid reference category.<sup>2,26</sup> This requirement led to the deletion of 300 to 400 subjects from the reference category, depending on the body site.

To measure perceived physical demands, the Job Content Questionnaire (JCQ) was used.<sup>27</sup> The JCQ has been validated, reliability tested, and normed on multiple occupations, and it contains measures of work demands (both physical and psychological), job strain, and other aspects of work. It has been used in relation to cardiovascular disease, MSD, depression, and other outcomes in the United States, Japan, and Europe.<sup>28</sup> Additional occupation-specific physical demand items, as recommended by Karasek<sup>27</sup> when studying a single occupation, were also incorporated. The items added were based on the literature, with content validity assessed by two experts in ergonomics and occupational health (see Table 1 for items).<sup>29-31</sup>

Each item was scored using a 4-point scale ("strongly agree" to "strongly disagree," or "often" to "never"). Responses were dichotomized (1 and 2 vs 3 and 4) and summed, generating total scores ranging from 0 to 12. Perceived physical demands were then categorized as low (0 to 2), medium (3 to 9), and high (10 to 12) demands, with the low category serving as the reference. The top and bottom 25% were defined as high and low demands, respectively. Internal consistency reliability for

**Table 1.** Age-adjusted odds of reported MSD cases by individual physical demands in working registered nurses, 1999–2000<sup>a</sup>

Physical demand Items	Neck MSD OR (95% CI)	Shoulder MSD OR (95% CI)	Back MSD OR (95% CI)
<b>My job requires:</b>			
Lots of physical effort <sup>b</sup>	1.86 (1.31–2.64)	1.72 (1.19–2.49)	2.17 (1.56–3.02)
Rapid and continuous physical activity <sup>b</sup>	1.52 (1.07–2.15)	1.39 (0.95–2.02)	1.81 (1.30–2.52)
<b>In my job I am:</b>			
Often moving/lifting very heavy loads <sup>b</sup>	2.17 (1.50–3.12)	1.94 (1.31–2.87)	2.81 (1.99–3.96)
Working for long periods with my head or arms in awkward positions <sup>b</sup>	6.20 (3.76–10.19)	6.31 (3.74–10.64)	4.88 (3.00–7.92)
Working for long periods with my body in awkward positions <sup>b</sup>	4.52 (2.80–7.30)	4.36 (2.63–7.22)	3.74 (2.35–5.96)
<b>How often in a typical workday do you:</b>			
Lift or lower patients/objects to/from floor	1.50 (0.99–2.28)	1.71 (1.08–2.69)	2.04 (1.34–3.08)
Lift or lower objects to/from shoulder height	2.13 (1.49–3.03)	2.17 (1.49–3.17)	2.17 (1.56–3.03)
Work while bent or twisted at waist	2.49 (1.47–3.56)	2.45 (1.67–3.59)	3.41 (2.43–4.81)
Push/pull heavy objects or people	1.94 (1.35–2.79)	1.56 (1.07–2.27)	2.56 (1.81–3.62)
Stand in one place/static position (>30 minutes)	1.57 (1.09–2.24)	1.87 (1.28–2.74)	1.69 (1.21–2.37)
Perform repetitive motions with hands/wrists	2.49 (1.71–3.63)	2.66 (1.77–3.98)	2.39 (1.69–3.37)
Apply pressure with hands/fingers (e.g., to prevent bleeding)	1.83 (1.28–2.61)	1.68 (1.15–2.45)	2.24 (1.60–3.13)

<sup>a</sup>Reference category for each demand is those without the demand, and is equal to odds ratio of 1.0.

<sup>b</sup>Original items from the Job Content Questionnaire.<sup>27</sup>

CI, confidence interval; MSD, musculoskeletal disorder; OR, odds ratio.

the 12 items was high, as measured by the coefficient  $\alpha=0.89$  for the sample.

Psychological demands were measured using the eight-item JCQ psychological demands scale: my job requires “working very hard,” “working very fast,” “an excessive amount of work,” “long periods of intense concentration on the task,” and “enough time to get the job done.” Other items in this scale follow: my job is “free from conflicting demands that others make,” “has tasks that are often interrupted before they can be completed,” and “requires waiting on work from other people or departments.”<sup>27</sup> Items were dichotomized (1 and 2 vs 3 and 4) and summed into a continuous demand score (reliability coefficient  $\alpha=0.78$  for the eight psychological demand items). Validity of the physical and psychological demand constructs was assessed using factor analysis with varimax rotation. Using an unrestricted factor solution, a technique used by Hollman et al.<sup>31</sup> to validate their physical workload questions, the psychological and physical demands were loaded on separate factors to indicate that they were distinct constructs.

Potentially confounding variables included in the study were lifestyle-related behaviors, such as exercise, smoking, and body mass index (all treated as continuous variables in the analysis), and demographics. All have been linked to musculoskeletal problems in the literature. Exercise and smoking were measured using single items. Body mass index was calculated, using weight in kilograms and height in meters-squared, and incorporated in the analysis as a continuous variable with the following modification: since weight

was measured categorically, the mean of weight categories was used following Tsuritani et al.<sup>32</sup>

Demographic variables included age, gender, race, having children aged <4 years, and caring for other dependents. Reference categories were males, Caucasian, having no children aged <4, and having no other dependents. Age, race, and gender were differentially distributed across nursing work settings and positions.<sup>33</sup> Young children and other dependents were assessed to identify nonwork responsibilities, as was done in MSD studies of largely female workforces.<sup>34</sup> Data on position and workplace were obtained for the current primary position listed by the registered nurse respondent.

## Data Analysis

Surveys were electronically scanned into a database, and handwritten responses were also reviewed to examine stray marks and comments. Data were cleaned using logic, range, and consistency checks. Estimates of the odds of being a reported MSD case (neck, shoulder, or back) were generated in relation to each perceived physical demand using logistic regression, with adjustment for age. Models were also generated using the categorized physical demands, adjusted for potential confounding factors. The covariates were forced together using forward entry of these variables. To examine subgroup differences in the workforce, separate models were generated for hospital and staff nurse subgroups, using the

**Table 2.** Adjusted odds ratios of reported MSD cases by level of physical demands in working registered nurses, 1999–2000

Variable	Neck MSD		Shoulder MSD		Back MSD	
	OR (95% CI)	<i>p</i> value	OR (95% CI)	<i>p</i> value	OR (95% CI)	<i>p</i> value
<b>Physical Demands Scale</b>						
Low (0–2)	1.00		1.00		1.00	
Mod (3–9)	2.15 (1.34–3.48)	0.002	2.40 (1.43–4.01)	0.001	2.60 (1.65–4.11)	0.000*
High (10–12)	4.98 (2.68–9.26)	0.000*	6.13 (3.14–11.98)	0.000*	5.30 (2.89–9.71)	0.000*
<b>Age (continued)</b>	1.02 (1.00–1.04)	0.072	1.04 (1.01–1.06)	0.004	1.01 (0.99–1.03)	.310
<b>Race</b>						
Caucasian	1.00		1.00		1.00	
Other	0.50 (0.27–0.91)	0.024	0.72 (0.39–1.33)	0.294	0.53 (0.31–0.94)	.028
<b>Has children aged &lt;4 years</b>						
No	1.00		1.00		1.00	
Yes	0.76 (0.48–1.20)	0.236	0.74 (0.43–1.27)	0.269	0.59 (0.38–0.91)	0.018
<b>Gender</b>						
Male	1.00		1.00		1.00	
Female	1.74 (0.62–4.91)	0.294	9.36 (1.15–76.35)	0.037	1.78 (0.69–4.58)	0.233
<b>Other dependents</b>						
No	1.00		1.00		1.00	
Yes	2.33 (1.29–4.22)	0.005	2.06 (1.11–3.81)	0.021	2.61 (1.49–4.59)	0.001
<b>Exercise (continued)</b>	0.82 (0.67–1.01)	0.064	0.87 (0.69–1.08)	0.205	0.76 (0.62–0.94)	0.011
<b>Smoking (continued)</b>	1.03 (0.85–1.24)	0.770	1.14 (0.94–1.38)	0.190	1.09 (0.91–1.30)	0.343
<b>Body mass index (continued)</b>	1.02 (0.98–1.07)	0.401	1.05 (1.00–1.01)	0.043	1.06 (1.02–1.11)	0.005
<b>Psych Demands Scale (continued)</b>	1.07 (1.01–1.14)	0.027	1.03 (0.97–1.10)	0.369	1.10 (1.03–1.16)	0.002

\**p*<0.0001.

CI, confidence interval; MSD, musculoskeletal disorder; OR, odds ratio.

same modeling procedure. Findings for these were compared to the findings for the overall sample.

## Results

Every perceived physical demand was significantly associated with reported back MSD, as indicated by confidence intervals that did not include 1.0. Furthermore, 11 of 12 demands were significantly associated with reported neck and shoulder MSD (Table 1). The strongest associations, especially with reported neck and shoulder MSDs, were for the awkward position items (head/arms and body). The associations of “moving or lifting heavy loads,” “lift or lower patients/

objects to/from the floor,” and “push/pull heavy objects or people” were stronger for the back than for neck or shoulder.

Both moderate and high levels of perceived physical demands were significantly related to the odds of reported MSDs at all body sites (Table 2). The odds increased for moderate and high levels of physical demands relative to the reference category. With the covariates in the models, the odds of reported MSD for the high physical demands category ranged from 4.98 to 6.13. Staff nurses had higher odds of reported MSD than the sample as a whole (compare Table 3 to Table 2). However, the odds were little changed for the

**Table 3.** Adjusted odds of MSD by physical demands stratified by workplace and position in working registered nurses, 1999–2000

Physical demands	Neck MSD <sup>a</sup> OR (95% CI)	Shoulder MSD <sup>a</sup> OR (95% CI)	Back MSD <sup>a</sup> OR (95% CI)
<b>Workplace: hospital nurses only (n = 660)</b>			
Low (0–2)	1.00	1.00	1.00
Mod (3–9)	1.42 (0.63–3.21)	1.37 (0.59–3.21)	2.28 (1.07–4.85)
High (10–12)	4.38 (1.75–10.99)	4.99 (1.84–13.57)	5.46 (2.24–13.31)
<b>Position: staff nurses only (n = 780)</b>			
Low (0–2)	1.00	1.00	1.00
Mod (3–9)	2.89 (1.36–6.15)	3.58 (1.58–8.11)	3.51 (1.72–7.18)
High (10–12)	9.05 (3.60–22.72)	11.99 (4.41–32.65)	9.39 (3.88–22.71)

<sup>a</sup>Models adjusted for age, race, children aged <4 years, other dependents, exercise, smoking, body mass index, and psych demands. Reference categories for categorical variables are Caucasian race, male gender, has no children aged <4 years.

CI, confidence interval; MSD, musculoskeletal disorder; OR, odds ratio.

hospital group from those of the overall sample.

## Discussion

In this cross-sectional survey, nursing environments with moderate and high perceived physical demands were associated with increased odds of reported MSD of the neck, shoulder, and back in registered nurses. As the perceived level of demands increased, so did the odds of reported MSD. The associations were stronger among staff nurses, perhaps reflecting the high proportion of direct patient-care activities in staff nursing jobs.<sup>35</sup>

Among the perceived physical demands studied here, those involving awkward positions were most strongly associated with reported MSD at all body sites. This is congruent with findings by others of increased injury to workers with excessive postural demands.<sup>19</sup> Biomechanical studies of forces and bodily loads have also demonstrated the danger of awkward positions and other patient-handling activities, such as transfers and repositioning, that exceed body tolerances.<sup>15,36</sup> In 2001, the Occupational Safety and Health Administration proposed an ergonomic standard to protect workers from MSDs<sup>37</sup> that was favored by the American Nurses Association, but Association approval was later rescinded.<sup>38</sup>

Both psychological and physical demands were significantly associated with reported back and neck injuries ( $p=0.002$  and  $p=0.027$ , respectively), but not with shoulder MSD. Kerr et al.<sup>39</sup> found that when self-rated physical demands were included in a model of back injuries, the significance of psychological demands disappeared.

Given the cross-sectional study design and the collection of data by self-report, these findings must be interpreted with caution. Self-report may reflect denial, deception, or difficulty in recall. By limiting the recall period for reported MSD to the past year, however, we restricted the time over which information needed to be remembered. Also, studies have supported the validity of self-reported symptom data, especially for reported MSDs, using a case definition with adequate thresholds.<sup>40</sup> Self-rating of physical work as demanding was found to correlate with higher heart rates, when monitored continuously for working nurses.<sup>41</sup> The stability of physical load measurements for posture was questionable in one study, although highly educated participants (commensurate with our nurse sample) had good to very good reliability ratings for these measures.<sup>42</sup>

Our exclusion of nonwork injury adds credibility to the findings, although misclassification was possible since cases with other chronic diseases, such as osteoarthritis, were not excluded from the analysis. A study of physical exposures comparing surveys to ergonomist

interviews found evidence of differential misclassification for those with musculoskeletal complaints, although the degree was too small to affect the risk estimates.<sup>43</sup> Furthermore, the cross-sectional design precluded us from drawing conclusions on the temporal order of relationships. Other limitations included lack of detailed data, such as pack-years of cigarettes smoked and the heart rate and duration of exercise, which left the potential for residual confounding. Personal psychosocial risks were also largely unaddressed in this study, as the focus of this study was on workplace issues.

Another concern is possible nonresponse and selection biases. While a response rate of 74% is very good for a mailed survey, we were unable to evaluate the nonrespondents. Nonetheless, when we looked at the number of demands perceived by those responding early versus those responding after repeated prompting, no differences were noted. Finally, since the analysis was limited to currently working nurses, we may have excluded nurses who had left jobs due to MSD or other health conditions. Thus, our data may underestimate reported MSD and the association of physical demands with MSD.

Despite its limitations, this study points to the importance of perceived work-related physical demands in relation to reported neck, shoulder, and back MSDs in nurses, especially staff nurses. Reported MSD in nurses has been associated with additional workplace consequences that may affect retention of nurses in their jobs. In our study, the proportion of registered nurses who reported ever changing jobs for a neck, shoulder, or back problem was 6%, 8%, and 11%, respectively. Yet intervention studies have shown good results in preventing MSD in nurses by reducing physical demands through the use of mechanical lifting devices, no-lift policies, and other administrative interventions.<sup>44-46</sup> Further inquiries are needed to identify other physical exposures that may be related to MSD, especially since these may be contributing to the loss of nurses from the profession.

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