

Surveillance of Musculoskeletal Injuries and Disorders in a Diverse Cohort of Workers at a Tertiary Care Medical Center

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Background *The purpose of this study was to investigate the incidence of work-related musculoskeletal (MSK) injuries and disorders among a dynamic cohort of health care workers, including direct care providers and support services, employed at a tertiary care medical center.*

Methods *Human resources data were used to define the cohort and time at risk. Workers' compensation (WC) records (1997–2003) were utilized to identify work-related MSK claims. Poisson regression was used to generate gender specific rate ratios and 95% confidence intervals (CI) of MSK injuries among workgroups.*

Results *MSK injuries resulted equally (~30% each) from lift/push/pull of equipment, patient handling, and slip/trip/falls. Injury rates and their mechanisms varied substantially by occupational group, gender, and race. Even with declining injury rates over time, black workers had rates 2.5 times higher than other workers and women had rates 1.8 times higher than men. Male and female nurses' aides, housekeepers, and radiology technicians had among the highest rates of injury, while lost workdays rates were highest for male and female nurses' aides, female housekeepers, and male patient transporters.*

Conclusions *Differential risk associated with work tasks in highly segregated work populations can contribute to disparities in health, and the patterns we observed partly reflect the high concentration of female and black workers in occupations with increased physical demands. While the greatest public health impact will be achieved by implementing prevention strategies among large workgroups with high injury rates, public health efforts must not ignore smaller, often segregated, workgroups identified in this study as high risk. Am. J. Ind. Med. 51:344–356, 2008. © 2008 Wiley-Liss, Inc.*

KEY WORDS: *musculoskeletal injuries; health care workers; race; gender; injury surveillance; health disparities*

INTRODUCTION

In 2004, hospitals in the U.S. employed almost 6 million workers [U.S. Department of Labor, 2005a]. In an effort to reduce costs in the health care industry over the past decade, there has been a shift in patient care from hospitals to home health [Bureau of National Affairs, 1998; Goodman, 2006]. Consequently, patients who require hospitalization are sicker and require more care resulting in increased work responsibilities for direct patient care providers such as physicians, nurses, nurses' aides, and radiology technicians. Downsizing efforts have also resulted in increased demands,

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not only among patient care providers, but also on necessary support staff such as housekeepers, food service employees, laundry services, administrative support, and maintenance workers [Engel, 1999].

The physical demands of these jobs are varied ranging from patient and materials handling activities to finer motor tasks. These exposures potentially place hospital workers at risk for acute musculoskeletal (MSK) injuries, as well as disorders associated with cumulative trauma [David and Buckle, 1997; Macfarlane et al., 1997; National Institute for Occupational Safety and Health, 1997; Engkvist et al., 2000; Russo et al., 2002]. Although a number of studies have focused on the risk of MSK injuries among nursing personnel [Fuortes et al., 1994; Engkvist et al., 2000], there has been little attention provided to the full spectrum of workers employed in health care institutions. The purpose of this surveillance study was to investigate the incidence of work-related MSK injuries and disorders among a diverse cohort of health care workers at a large tertiary care medical center.

MATERIALS AND METHODS

The data for these analyses come from the Duke Health and Safety Surveillance System (DHSSS) which was designed to provide comprehensive information on the large and diverse cohort of health care workers employed at Duke University Medical Center located in central North Carolina. This cohort includes all workers involved in the day-to-day operations of the tertiary care medical center. For these analyses, we used human resources' administrative data and workers' compensation (WC) records linked on an individual basis. After data were linked, all identifying information was removed from the database so that individual workers could not be identified. A detailed description of how the DHSSS was constructed and how these data are linked and de-identified has been previously published [Dement et al., 2004]. All procedures were approved by the Duke University Medical Center Institutional Review Board.

Population and Time at Risk

The dynamic cohort of health care workers employed at the medical center from 1997 through 2003, their occupation, duration of employment, gender, race, and years of age were identified through human resources' administrative data. Administrative codes were used to identify health care workers employed at Duke University Medical Center and these analyses include all hospital workers, associated on-site and off-site clinics, laboratories, and administrative support services. Workers employed at two other hospitals within this surveillance system, Durham Regional and Raleigh Community, were not included in these analyses. To provide a measure of time at risk, work time, expressed as full-time equivalents (FTEs) was estimated for each worker

by year of follow-up using the worker's usual work schedule (hours per week) and duration of employment at the medical center for each year. A worker employed for 40 hr per week and employed for the entire year contributed one FTE (1 FTE = 2,000 work hours per year per worker).

Outcomes of Interest

MSK injury and disorder claims

Reported cases of work-related MSK injuries and disorders were captured through the WC claims data provided through the medical center's self-insured compensation program for the 7 years of observation. Employees have the option of reporting work-related injuries through an online reporting system or by completing a workplace injury form. Initially, we identified claims accepted for WC coverage with the nature of injury coded as pain/inflammation, sprain/strain, carpal tunnel syndrome, or dislocation. Claims were then further restricted to include only those with a cause code of fall/slip, exertion, lifting, push/pull, repetitive motion, or bodily reaction. The WC database also included OSHA equivalent information about whether or not the injuries resulted in restricted and/or lost workdays, as well as the total number of days lost from work per claim.

Analyses

Descriptive statistics were generated to describe the population of health care workers based on gender, race, occupational group, and time varying variables of age and years of employment at the medical center, and time at risk for work-related injuries or disorders (FTEs). After identifying all claims meeting our definition of MSK injuries and disorders, frequencies of overall claims as well as those resulting in restricted workdays, and lost workdays, and the total number of days lost from work were calculated. For these analyses, restricted workday injuries consisted of any claim that resulted in a physician prescribed reduction in a worker's regular work assignment, regardless of whether or not it also involved lost workdays. The distribution of mechanism of injury was assessed for each occupational group.

Crude rates of MSK claims filed through WC were stratified by age, gender, race, and employment tenure allowing for comparisons across demographic and employment characteristics. Incidence density rates were calculated separately for all MSK injury claims and those that resulted in restricted or lost workdays. The rates of injury over the 7-year observation period were examined, and an evaluation of injury rate trends for selected occupational groups was conducted. To better estimate the burden of these injuries and disorders, rates of the total number of days lost from work per 100 FTEs were calculated. Confidence intervals (CI) (95%)

were calculated as described by Haenzel et al. [1962] assuming a Poisson distribution.

Multivariate models were constructed for the purpose of identifying occupational groups at higher risk for MSK injuries and disorders through WC. To provide relatively stable injury rates, occupational groups with at least 200 FTEs in size, that had overall injury rates of at least 2.0 per 100 FTEs, were selected to be included in these analyses. The reference group for the occupational variable included all jobs where the crude rate for MSK claims was 1.0 per 100 FTEs or less (smaller occupational groups (<200 FTEs) with injury rates of at least 2.0/100 FTEs, as well as larger occupational groups (>200 FTEs) with injury rates between 1.0 and 2.0/100 FTEs were not highlighted in the analyses).

It is not unusual for jobs in the health care industry to be highly segregated by race and gender, and for workers of color to hold more physically demanding jobs [King, 1992; Gluck and Oleinick, 1998; US DOL, 2005a]. Since this held true in this population of health care workers, we chose to stratify our analyses by gender prior to constructing the multivariate models. In addition, within these gender specific models we excluded race as a possible confounder in order to avoid over-adjustment.

Adjusted rate ratios and 95% CI were calculated using Poisson regression [Nizim, 2000] with the log of FTEs included as an offset term. When assessing the risk of total days lost from work, we used generalized estimating equations (GEE) [Liang and Zeger, 1986; Zeger et al., 1988] in the Poisson model to account for statistical dependence between days lost from work per employee. Years of age and duration of employment were assessed as possible confounders and were retained in the model if they changed any level of the explanatory variable (occupational group) or other covariates in the model by more than 10%, or if they were independently associated with the rate of injury (based on the Type 3 likelihood ratio statistic). All analyses were conducted using SAS Version 9.1.3 [2004].

RESULTS

Description of the Cohort

Over 7 years of observation, the medical center employed an average of 19,487 workers per year, with half consisting of full-time employees throughout a given year, and the remaining half who worked either part of a year or part-time for an entire year. Demographic characteristics of the overall cohort, and those of the 14 occupational groups with the highest rates of WC MSK injury and disorders (and the reference group) are presented in Table I. More than half (66%) of the cohort were women. The majority of workers were white (68%); the non-white population was predominantly black (24%). The mean age of workers over

this time period was 39.9 years for both men and women. They averaged 8.6 years of employment at the medical center over the 7 years with 50% having been employed for 5 years or less. As expected, some of those in the higher risk occupational groups are responsible for direct patient care including nurses' aides, inpatient nurses, radiology technicians, and physical/occupational therapists. Several other high-risk occupations include service occupations such as housekeeping, laundry, and dietary services. Smaller workgroups such as medical supply assemblers (sterilize and package surgical supplies), lab animal technicians (handle laboratory animals and animal cages), and skilled craft workers were also identified, in addition to secretarial/clerical staff who represented the largest of the 14 workgroups.

With the exception of patient transporters, lab animal technicians, and skilled craft workers, women made up more than half of the higher risk groups, with several groups consisting of at least 70% women. Half of these workgroups consisted of 63–99% black workers.

Work-Related MSK Claims

A total of 2,849 WC MSK claims were filed among 102,669 FTEs resulting in an overall crude rate of 2.8 (95% CI: 2.7, 2.9) claims per 100 FTEs (Table II). More than half of the MSK claims resulted in restricted ($n = 1516$; 53%) and lost workdays ($n = 430$; 15%). Workers lost 48,911 days due to an MSK injury or disorder representing 47.6 lost workdays per 100 FTEs overall.

Female workers had higher rates of injury and restricted workdays compared to male workers (Table II). Black workers were five times more likely to incur a work-related injury, resulting in restricted workday rates that were three times higher than white workers. The burden of injury with respect to the number of days lost from work was also notably higher among women and black workers than their male and white counterparts. Rates of injury were similar across age groups and years of service; however, an increase in the number of days lost from work was seen with increasing age. Those working less than 5 years at the medical center or more than 20 years had lower rates of lost workdays compared to those who worked 6 through 20 years.

Mechanism of Injury

Approximately 90% of all MSK injuries and disorders attributed equally to lifting, pushing, or pulling of work equipment (31%), patient handling (31%), or slips, trips, and falls (STF) (30%) while significantly fewer injuries resulted from walking or body movement (6%) or computer work (4%) (Table III). As expected, patient handling injuries were concentrated among workers responsible for direct care including nurses' aides, inpatient nurses, radiology

TABLE I. Demographic Characteristics of Health Care Workers at Increased Risk for Musculoskeletal Injuries and Disorders, 1997–2003

Occupation	All workers	Gender		Race ^a		Years of age	Years employed at hospital
	FTEs	% Female	% Male	% Black	% White	Mean; median	Mean; median
All workers	102,669	66	34	24.4	67.7	39.9; 39.0	8.6; 4.8
Direct patient care							
Clinical technician	6,671	70	30	29.2	66.0	39.6; 39.0	9.4; 6.9
Nurse—inpatient	10,624	89	11	17.0	76.6	38.5; 38.0	7.7; 4.6
Nurse—outpatient	4,293	94	6	15.7	82.3	44.2; 45.0	11.8; 10.3
Nurses' aide	2,192	80	20	67.7	23.8	37.3; 36.0	6.0; 2.6
Patient transporter	328	48	52	81.7	16.6	40.9; 40.0	9.0; 5.3
Physical/occupation therapist	707	72	28	3.8	95.0	36.3; 35.0	5.3; 3.4
Radiology technician	1,765	68	32	28.0	72.0	37.1; 36.0	7.6; 4.6
Service							
Dietary service	1,298	79	21	95.8	2.5	41.6; 41.0	14.5; 13.9
Housekeeper	2,932	58	42	91.0	6.5	43.0; 42.0	10.0; 8.0
Laundry staff	282	66	34	98.1	1.5	46.8; 47.0	13.9; 12.9
Other							
Lab animal technician ^b	241	40	60	55.4	37.4	39.5; 38.0	10.3; 6.4
Medical supply assembler ^c	332	62	38	82.0	10.0	42.9; 41.0	13.1; 14.0
Secretary/clerical staff	18,679	88	12	45.2	53.1	40.8; 41.0	10.3; 6.9
Skilled craft	581	11	89	39.6	62.4	43.7; 45.0	13.0; 13.1
Other workgroups ^d	4,821	77	23	31.0	65.4	40.8; 40.0	8.0; 4.2
Reference hospital workgroups ^e	46,923	49	51	17.7	79.1	39.5; 38.0	7.5; 4.0

^aStudy cohort (8%) consists of workers of races other than black and white.

^bLab animal technician provides care for lab animals which involves handling animals and animal cages.

^cMedical supply assemblers package and sterilize medical equipment.

^dOccupational groups that did not meet study criteria for inclusion in the reference group (injury rate $\leq 1.0/100$ FTEs) or as a high-risk workgroup (injury rate $\geq 2.0/100$ FTEs and workgroup size of at least 200 FTEs).

^eReference category: occupational groups whose overall rate of WC MSK claims $\leq 1.0/100$ FTEs.

technicians, physical/occupational therapists, and patient transporters. Moreover, a small number of secretarial/clerical staff incurred patient handling injuries. Upon further exploration, these injuries occurred among secretaries and clerical staff working on either inpatient units or outpatient clinics who assisted patients who were either being admitted or checking in for an appointment. The handling of work equipment was the most common mechanism of injury among housekeepers, dietary service workers, lab animal technicians, medical supply assemblers, laundry and skilled craft workers. Unexpectedly, almost half of all injuries incurred by secretarial/clerical support resulted from STF while few (13%) resulted from computer work, such as typing and data entry.

Rates of Injury Over Time

Rates of injury declined over time from 3.3/100 FTEs (95% CI: 3.0, 3.6) in 1997 to 2.4/100 FTEs (95% CI: 2.1, 2.6) in 2003, despite a hospital wide downsizing effort in 1999.

Blacks consistently had injury rates 2.5 times higher than other workers, and women had injury rates approximately 1.8 times higher than men over the 7 years of observation despite proportionately greater declines in their injury rates (Figs 1 and 2).

Changes in the rates of injury over time also varied across occupational groups. For example, injury rates among nurses' aides declined over 50% from 1997 (crude rate: 16.4; 95% CI: 11.7, 21.1) through 2003 (crude rate: 7.8; 95% CI: 4.8, 11.1) (Fig. 3). In contrast, with the exception of a decline in injury rates in 1999 (crude rate: 4.5; 95% CI: 2.5, 6.7), the rates of injury for housekeepers have steadily increased through 2003 (crude rate: 11.3; 95% CI: 8.2, 14.5), with a positive test for trend observed for rates from 1999 through 2003 (trend data not shown). Rates among nurses, outpatient nurses and secretarial and clerical staff (data not shown) were consistent over time. Some workgroups were too small to calculate stable injury rates over time such as patient transporters, laundry, skilled craft workers, and physical/occupational therapists.

TABLE II. Crude Rates of Workers' Compensation Musculoskeletal Claims by Demographic Characteristics of Workers, 1997–2003

	FTEs	MSK Claims		Restricted workday MSK claims ^a		Number of lost workdays		
		No.	Crude rate ^b (95% CI)	No.	Crude rate ^b (95% CI)	No. lost workday claims	No. lost days	Crude rate ^c (95% CI)
All workers	102,669	2,849	2.8 (2.7, 2.9)	1,516	1.1 (1.1, 1.2)	430	48,911	47.6 (47.2, 48.1)
Gender								
Female	68,219	2,236	3.3 (3.1, 3.4)	1,184	1.7 (1.6, 1.8)	312	38,358	56.2 (55.7, 56.8)
Male	34,450	613	1.8 (1.6, 1.9)	332	0.96 (0.86, 1.1)	118	10,553	30.6 (30.1, 31.2)
Race								
Black	26,041	1,340	5.2 (4.9, 5.4)	803	3.1 (2.9, 3.3)	234	27,202	104.5 (103.2, 105.7)
White	69,467	1,407	2.0 (1.9, 2.1)	661	0.95 (0.88, 1.0)	177	21,372	30.8 (30.4, 31.2)
Other	7,161	102	1.4 (1.2, 1.7)	52	0.73 (0.53, 0.92)	19	337	4.7 (4.2, 5.2)
Age (years)								
<25	5,186	132	2.6 (2.1, 3.0)	68	1.3 (1.0, 1.6)	15	145	2.8 (2.3, 3.3)
25–34	28,374	699	2.5 (2.3, 2.7)	478	1.5 (1.4, 1.7)	143	7,293	25.7 (25.1, 26.3)
35–44	31,340	899	2.9 (2.7, 3.1)	429	1.7 (1.5, 1.8)	122	13,352	42.6 (41.9, 43.3)
45–54	25,909	793	3.1 (2.9, 3.3)	162	1.4 (1.2, 1.6)	52	18,173	70.1 (69.1, 71.2)
≥55	11,860	326	2.8 (2.5, 3.1)	379	1.3 (1.2, 1.5)	98	9,948	83.9 (82.2, 85.5)
Years worked at medical center								
≤5	45,417	1,168	2.6 (2.4, 2.7)	631	1.4 (1.3, 1.5)	168	13,477	29.7 (29.2, 30.2)
6–10	19,137	486	2.5 (2.3, 2.8)	274	1.4 (1.3, 1.6)	78	14,227	74.3 (73.1, 75.6)
11–15	14,152	437	3.1 (2.8, 3.4)	227	1.6 (1.4, 1.8)	68	10,914	77.1 (75.7, 78.6)
16–20	8,942	292	3.3 (2.9, 3.6)	156	1.7 (1.5, 2.0)	57	6,814	76.2 (74.4, 78.0)
>20	15,019	466	3.1 (2.8, 3.4)	228	1.5 (1.3, 1.7)	59	3,479	23.2 (22.4, 23.9)

^aClaims that resulted in restricted workdays regardless of whether or not they also resulted in lost workdays.

^bCrude rate = no. WC MSK claims per 100 FTEs.

^cCrude rate = no. days lost from work per 100 FTEs.

Injury Rates Stratified by Gender

The risk of MSK injuries and disorders, restricted workdays, and total lost workdays among the 14 high-risk workgroups are presented for female workers in Table IV and male workers in Table V. The stratified analyses resulted in different baseline risk estimates for the reference groups for men and women. Therefore, occupational specific rates can be compared across genders while the rate ratios are only appropriate for gender specific internal comparisons.

The female reference group had an overall injury rate (0.77/100 FTEs) and restricted workday injury rate (0.35/100 FTEs) that was more than double the rates for the male reference group (0.30/100 FTEs and 0.14/100 FTEs, respectively) even though they included the same occupational groups. Male and female reference groups had comparable rates of lost workdays.

Female workers

Rate ratios among high-risk female workgroups compared to the female reference workgroups ranged from 2.9 among secretarial staff to 34.6 among lab animal

technicians (Table IV). Within the patient care occupations, nurses' aides had notably higher rates of injuries (12.1/100 FTEs) compared to other workgroups including inpatient and outpatient nurses. Radiology technicians, inpatient nurses, and patient transporters had comparable rates (~7.0/100 FTEs), while the rate of injuries for outpatient nurses was considerably less. Rates of claims resulting in restricted workdays followed a similar pattern to overall claims. The proportion of nurses' aides whose injuries resulted in restricted workdays was 63% (135 of 213 claims), compared to 49% of inpatient nurses (311 of 624 claims). Nurses' aides had markedly higher rates of lost workdays compared to other patient care providers, while radiology technicians had only four claims that resulted in few lost workdays. Female service workers, including housekeepers, dietary service workers, and laundry workers had comparable overall injury (~11.0 claims/100 FTEs) and restricted workday (~7.0/100 FTEs) rates. All three groups had a high proportion of injuries that resulted in restricted workdays; however, housekeepers went on to incur a markedly higher rate of days lost; their injuries accounted for 25% of all lost workdays among the female workforce. The highest rates of injury (25.9 and 15.0/100 FTEs) and restricted (15.5 and

TABLE III. Mechanism of Workers' Compensation Injuries and Disorders Among Selected Workgroups, 1997–2003

	Lift/push/pull equipment n = 893; 31%	Patient handling n = 886; 31%	Slips/trips/falls n = 800; 28%	Walking/body movement n = 165; 6%	Computer work n = 105; 4%
	n (%)	n (%)	n (%)	n (%)	n (%)
Direct patient care					
Clinical technician	61 (33.2)	23 (12.5)	77 (41.9)	19 (10.3)	4 (2.2)
Nurse—inpatient	79 (12.0)	431 (63.2)	144 (21.1)	28 (4.1)	—
Nurse—outpatient	12 (11.3)	33 (31.1)	44 (41.5)	8 (7.6)	9 (8.5)
Nurses' aide	22 (8.3)	205 (77.7)	29 (11.0)	8 (3.0)	—
Patient transporter	6 (26.1)	14 (60.9)	3 (13.0)	—	—
Physical/occupation therapist	1 (3.6)	19 (67.9)	5 (17.9)	3 (10.7)	—
Radiology technician	29 (22.3)	83 (63.9)	12 (9.2)	4 (3.1)	2 (1.5)
Service					
Dietary service	80 (59.3)	—	46 (34.1)	7 (5.2)	2 (1.5)
Housekeeper	170 (68.3)	—	60 (24.1)	19 (7.6)	—
Laundry staff	26 (66.7)	—	7 (18.0)	6 (15.4)	—
Other					
Lab animal technician	34 (77.3)	—	5 (11.4)	5 (11.4)	—
Medical supply assembler	31 (81.6)	—	7 (18.4)	—	—
Secretary/clerical staff	146 (34.2)	12 (2.8)	187 (43.8)	26 (6.1)	56 (13.1)
Skilled craft	29 (72.5)	—	7 (17.5)	3 (7.5)	1 (2.5)
Other workgroups ^a	79 (37.6)	50 (23.8)	63 (30.0)	14 (6.7)	4 (1.9)
Reference hospital workgroups ^b	88 (35.2)	16 (6.4)	104 (41.6)	15 (6.0)	27 (10.8)

^aOccupational groups that did not meet study criteria for inclusion in the reference group (injury rate $\leq 1.0/100$ FTEs) or as a high-risk workgroup (injury rate $\geq 2.0/100$ FTEs and workgroup size of at least 200 FTEs).

^bReference category: occupational groups whose overall rate of WC MSK claims $\leq 1.0/100$ FTEs no claims filed.

10.1/100 FTEs) workdays were observed in the two smallest workgroups, including lab animal technicians and medical supply assemblers, respectively. Secretaries and clerical staff had a modest overall injury rate, but incurred numerous lost days from work second only to housekeepers.

Male workers

Among male workers, the largest workgroup included secretarial staff who had the lowest risk of MSK

injury (RR: 8.8) compared to the smallest workgroup of laundry workers who had the highest (RR: 61.0) (Table V). The rates of injury among direct patient care providers was highest among male nurses' aides (11.8/100 FTEs), followed by radiology technicians and patient transporters, whose rates were similar (~8.0/100 FTEs). Although the total number of injuries that resulted in lost workdays among patient care providers was modest, male nurses' aides and patient transporters lost a considerable number of workdays. Within male service workers, laundry workers had signifi-

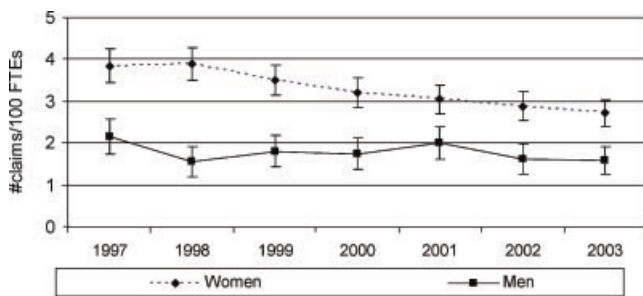


FIGURE 1. Annual rates and 95% CI of WC MSK injuries and disorders stratified by gender, 1997–2003. WC, workers' compensation; MSK, musculoskeletal; CI, confidence interval.

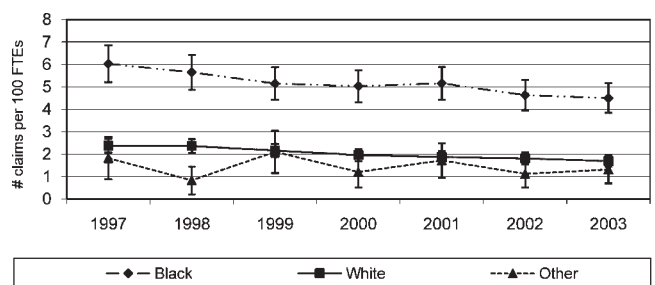


FIGURE 2. Annual crude rates and 95% CI of WC MSK injuries and disorders stratified by race, 1997–2003. WC, workers' compensation; MSK, musculoskeletal; CI, confidence interval.

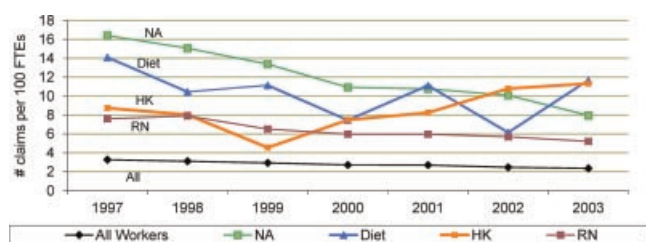


FIGURE 3. Annual crude rates of WC MSK injuries and disorders stratified by selected occupational groups, 1997–2003. NA, nurses' aide; Diet, dietary workers; HK, housekeepers; RN, inpatient nurse; WC, workers' compensation; MSK, musculoskeletal. A positive test for trend was observed for rates of injury among HK from 1999 to 2003.

cantly higher rates of injury (18.7/100 FTEs) compared to housekeepers and dietary workers (~8.0/100 FTEs). Similar to female housekeepers, male housekeepers incurred a substantial number of days away from work. Among the remaining workgroups, lab animal technicians had among the highest rates of injuries (13.2/100 FTEs), while skilled craft workers, which consists mostly of male workers, incurred 6.8 injuries per 100 FTEs. Male secretarial and clerical staff had the lowest rates of injury, but incurred more lost workdays than any other workgroup in the male workforce.

DISCUSSION

Using an existing passive surveillance system which links multiple data sources on an individual basis [Dement et al., 2004], we were able to evaluate reported work-related MSK injuries and disorders among diverse workgroups in a large tertiary care medical center over a 7-year time period. In so doing, we observed significant differences in work-related MSK injuries and disorders based on occupation, as well as differences in risk based on race and gender. Black workers represented only 26% of the cohort, but they filed 44% of the claims; while female workers, who made up 66% of the workforce, filed 78% of the claims. Higher overall rates of injury, as well as injuries that resulted in restricted and/or lost workdays, were observed among female and black workers compared to male and white workers, respectively. The findings reflect, at least in part, the nature of the jobs predominately held by these workers. Despite declines in their injury rates over time, blacks consistently had MSK injury rates that were 2.5 times higher than other workers, and women had almost 2 times higher injury rates than men over the 7 years of observation.

In a number of occupational groups, the gender specific injury rates and rates of lost workdays were similar while for others they were different. Male and female nurses' aides, housekeepers, dietary services, radiology technicians, and inpatient nurses were among those with the highest rates of

MSK injury and disorder. In contrast, female medical supply assemblers and lab animal technicians had injury rates at least twice as high as their male counterparts in the same occupational groups, while male laundry workers and patient transporters had injury rates that were 70 and 40% higher, respectively, than female workers in the same job. As observed in prior studies, differences in injury rates between males and females in the same broad job category may reflect differences in work tasks and, consequently, exposures [Messing et al., 1994; Saleh et al., 2001; Hooftman et al., 2005].

We also observed differences in injury rates over time by occupational group. Declining injury rates were seen among nursing staff with a more substantial decline among nurses' aides. In this case, the decline may reflect significant institutional efforts to address ergonomic problems faced by nursing personnel that resulted in a defined nursing ergonomics task force in 2001. In contrast, injury rates among housekeepers increased during the same time period.

Differences in the burden of injury by rates of days lost from work was also observed. Among the larger workgroups, both male and female housekeepers and nurses' aides had high rates, while smaller workgroups including laundry staff, medical supply assemblers, and lab animal technicians also had high rates. Keeping injured employees at work by means of restricted work assignments may be difficult to achieve for workers in physically demanding jobs, as observed in prior studies of housekeepers [Messing et al., 1998] and nurses' aides [Eriksen et al., 2003]. Within this medical center, return to work assignments are determined individually within each department which may explain some of the variation in restricted workday injury rates across departments. However, regardless of occupational group, a higher proportion of injuries resulted in restricted rather than lost workday injuries. This may reflect a concentrated effort that this hospital has made to keep injured employees engaged in the workforce, even in a reduced work capacity, since lost workday injuries could result in a worker's inability to return at all [Dasinger et al., 1999; Tate et al., 1999; Krause et al., 2001]. Within nursing personnel, the higher rates of restricted workday injuries and lost days from work among nurses' aides compared to nurses may reflect higher decision latitude among nurses compared to nurses' aides [Seago and Faucett, 1997] which influences not only what they do, but how their work is structured; both could impact direct exposure and accommodation in the workplace after injury. This is consistent with focus group findings among nurse managers, inpatient nurses, and nurses' aides at this medical center [Pompeii et al., 2007]. For example, nurses may be more able to rearrange their work schedule to take time off from work to accommodate an injury compared to nurses' aides.

For some occupational groups, the patterns of lost workday rates did not correlate with the overall rates of MSK

TABLE IV. The Risk of Work-Related Musculoskeletal Injuries and Disorder Claims, Restricted Workday Claims, and Lost Workdays Among Female Workgroups, 1997–2003

Occupational group (FTEs)	Female workers														
	All MSK claims					Restricted workday MSK claims ^a					Lost workdays resulting from MSK claims				
	FTE	No. claims	Crude claim rate ^b	Rate ratio (95% CI) ^c	No. claims	Crude claim rate ^b	Rate ratio (95% CI) ^c	No. lost day claims	No. days lost	Crude lost day rate ^d	Rate ratio (95% CI) ^e				
All female workers	68,219	2,236	3.3	—	1,184	1.7	—	312	38,358	56.2	—				
Patient care providers															
Clinical technician	4,682	146	3.1	4.0 (3.7, 4.4)	57	1.2	3.5 (3.1, 3.9)	19	1,531	32.7	6.6 (0.86, 51.1)				
Nurse—inpatient	9,504	624	6.6	8.6 (8.0, 9.2)	311	3.3	9.3 (8.6, 10.1)	83	7,120	74.9	15.3 (3.4, 68.8)				
Nurse—outpatient	4,017	103	2.6	3.2 (2.9, 3.5)	46	1.2	3.2 (2.8, 3.6)	11	2,604	64.8	11.2 (1.6, 86.2)				
Nurses' aide	1,758	213	12.1	15.8 (14.5, 17.2)	135	7.7	21.8 (20.0, 23.9)	34	5,226	297.3	67.1 (12.5, 359.7)				
Patient transporter	158	9	5.7	7.3 (5.5, 9.6)	4	2.5	7.2 (5.2, 10.0)	3	29	18.4	—				
Physical/occupation therapist	511	21	4.1	5.4 (4.5, 6.5)	10	2.0	5.6 (4.5, 6.9)	1	6	1.2	—				
Radiology technician	1,200	85	7.1	9.3 (8.4, 10.4)	39	3.3	9.3 (8.3, 10.6)	4	20	1.7	—				
Service workers															
Dietary service	1,020	110	10.8	13.9 (12.6, 15.4)	68	6.7	19.6 (17.6, 21.8)	20	580	56.9	12.9 (2.6, 64.2)				
Housekeeper	1,706	166	9.7	12.3 (11.3, 13.5)	107	6.3	17.6 (16.1, 19.4)	52	10,368	607.9	102.8 (23.2, 455.0)				
Laundry staff	186	21	11.3	14.5 (12.0, 17.5)	16	8.6	24.9 (21.0, 29.7)	6	139	75.0	34.2 (3.0, 38.7)				
Other															
Lab animal technician	97	25	25.9	34.6 (29.1, 41.1)	15	15.5	46.8 (38.3, 54.7)	6	85	88.0	24.9 (4.1, 152.3)				
Medical supply assembler	207	31	15.0	19.2 (16.4, 22.5)	21	10.1	29.7 (25.4, 34.7)	4	341	164.5	34.2 (3.0, 38.7)				
Secretary/clerical staff	16,483	368	2.2	2.9 (2.7, 3.1)	206	1.3	3.6 (3.9, 3.9)	45	8,024	48.7	100 (2.2, 45.9)				
Skilled craft	64	5	7.8	10.0 (7.0, 14.5)	4	6.4	17.9 (13.0, 24.8)	0	—	—	—				
Reference female workers ^e	22,917	177	0.77	1.0	81	0.35	1.0	12	1,110	4.8	1.0				

MSK, musculoskeletal; FTE, full-time equivalent; CI, confidence interval.
 Note: Female workers in the "other workgroup" category are not included in this table (WC claims = 132, FTEs = 3,709).
^aClaims that resulted in restricted workdays regardless of whether or not they also resulted in lost workdays.
^bCrude rates = no. claims per 100 FTEs.
^cAdjusted for age and years employed at hospital.
^dCrude rates = no. days lost from work per 100 FTEs.
^eReference category: female occupational groups whose overall rate of WC MSK claims \leq 1.0/100 FTEs less than five claims.

TABLE V. The Risk of Work-Related Musculoskeletal Injuries and Disorder Claims, Restricted Workday Claims, and Lost Workdays Among Male Workgroups, 1997 – 2003

Occupational group (FTEs)	Male workers														
	All MSK claims					Restricted workday MSK claims ^a					Lost workdays resulting from MSK claims				
	No. claims	FTE	Crude claim rate ^b	Rate ratio (95% CI) ^c	No. claims	Crude claim rate ^b	Rate ratio (95% CI) ^c	No. lost day claims	No. lost days	Crude lost day rate ^d	Rate ratio (95% CI) ^e				
All male workers	613	3,4450	1.8	—	332	0.96	—	118	10,553	30.6	—				
Patient care providers															
Clinical technician	38	1,989	1.9	6.1 (5.4, 6.9)	21	1.1	7.7 (6.8, 8.8)	5	133	6.7	1.3 (0.14, 11.2)				
Nurse—inpatient	58	1,120	5.2	17.0 (15.2, 18.8)	22	2.0	13.8 (12.1, 15.7)	7	381	34.0	7.0 (0.70, 70.0)				
Nurse—outpatient	3	276	1.1	—	3	1.1	—	1	2	0.72	—				
Nurses' aide	51	434	11.8	38.6 (34.6, 43.1)	35	8.1	60.3 (53.8, 67.6)	8	1,497	344.8	71.0 (8.3, 603.6)				
Patient transporter	14	170	8.2	26.9 (22.6, 32.0)	10	5.9	43.7 (36.8, 51.7)	5	1,110	651.8	128.1 (12.6, 1,307.3)				
Physical/occupation therapist	7	196	3.6	11.7 (9.2, 14.8)	4	2.0	14.2 (11.1, 18.2)	0	0	—	—				
Radiology technician	45	565	8.0	26.0 (23.2, 29.1)	22	3.9	28.5 (25.0, 32.4)	7	113	200	1.5 (0.47, 39.9)				
Service workers															
Dietary service	25	278	9.0	28.8 (25.1, 33.1)	14	5.0	37.6 (32.4, 43.8)	2	31	11.2	2.5 (0.20, 32.7)				
Housekeeper	83	1,226	6.8	22.1 (20.1, 24.4)	48	3.9	29.5 (26.5, 32.8)	22	1,855	151.3	30.7 (3.6, 264.1)				
Laundry staff	18	96	18.7	61.0 (51.9, 72.4)	6	6.3	45.6 (36.9, 56.2)	1	50	52.1	6.5 (0.44, 94.1)				
Other															
Lab animal technician	19	144	13.2	43.1 (36.9, 50.3)	15	10.4	76.7 (66.2, 88.8)	4	33	22.9	4.5 (0.42, 48.6)				
Medical supply assembler	7	125	5.6	18.1 (14.3, 23.9)	2	1.6	—	0	0	—	—				
Secretary/clerical staff	59	2,196	2.7	8.8 (7.9, 9.8)	37	1.7	12.4 (11.1, 13.9)	20	2,624	119.6	25.3 (3.0, 214.9)				
Skilled craft	35	517	6.8	21.8 (19.2, 24.7)	19	3.7	27.9 (24.3, 32.0)	10	536	103.7	17.5 (2.5, 121.7)				
Reference male workers ^e	73	24,006	0.30	1.0	33	0.14	—	9	1,232	5.1	1.0				

MSK, musculoskeletal; FTE, full-time equivalent; CI, confidence interval.

Note: Male workers in the "other workgroup" category are not included in this table (WC Claims = 78, FTEs = 1,112).

^aClaims that resulted in restricted workdays regardless of whether or not they also resulted in lost workdays.

^bCrude rates = no. claims per 100 FTEs.

^cAdjusted for age and years employed at hospital.

^dCrude rates = no. days lost from work per 100 FTEs.

^eReference category: male occupational groups whose overall rate of WC MSK claims ≤ 10/100 FTEs less than five claims.

claims. For example, outpatient clinic nurses had significantly lower rates of MSK injury claims compared to inpatient nurses; however, their rates of lost days from work, incurred from a smaller number of cases, were similar. These findings may reflect a pattern of migration among seasoned inpatient nurses to the outpatient clinical setting, especially when the physical demands of their job are too great. Job satisfaction, lower turnover, and lower physical demands have been reported among nurses employed in the outpatient clinical setting compared to the inpatient nursing unit [Hart, 2001]. Radiology technicians, including sonographers and X-ray technicians, had low rates of lost workdays relative to their overall injury rate, which is not unique to our study [Magnavita et al., 1999]. Although radiology technicians perform similar patient handling tasks as other patient care providers, their work is not concentrated in constant patient care. Perhaps the nature of their work allows them to modify their workload in ways that enable them to remain at work; however, these findings need to be further explored.

An unexpected finding was the high rate of lost workdays among both male and female secretarial staff in addition to a high proportion of their injuries that resulted from STF compared to those incurred from computer work. The high rate of lost workdays is consistent with prior studies indicating that workers with low back pain have difficulty returning to jobs that require prolonged sitting [Krause et al., 2001]; however, the nature of the injuries that these workers are experiencing are not consistent with what is known about their work tasks. Of note, STFs were responsible for one-third of MSK injuries and disorders in our study, and they occurred across all occupational groups. A study among hospital workers [Collins et al., 2006; Courtney et al., 2006] reported similar findings of office clerical workers, as well as nursing staff, who had the highest frequency of same level STF injuries. Moreover, food service, housekeeping, and EMS/Transport workers had the highest rates of same level STF injuries in their study and these incidents resulted from objects being left on the floor (i.e., medical equipment, laundry bags), slippery floor conditions (i.e., water/ice, grease), or floor surface irregularities. These findings support national surveillance data [US DOL, 2004] that hospitals have among the highest rates of same level STF injuries compared to other industries.

Limitations and Strengths

We acknowledge a number of limitations in these analyses. First, we used claims that were reported and accepted through the WC system; obviously our findings are colored by factors that influence either of these processes. Significant underreporting has been documented in WC records [Pransky et al., 1999; Shannon and Lowe, 2002], as well as the administrative tracking of lost workdays

[Dasinger et al., 1999]. Our measure of injury burden, total number of days lost, did not capture lost workdays among employees with flexible work schedules (e.g., three-12 hr shifts) who may have rearranged their workdays to accommodate their needs for recovery time. Moreover, at the time of these analyses some workers were still accruing days lost from work as a result of their MSK injuries. In light of these things, we believe our results are likely conservative estimates of injury risk and burden.

We did not have individual level data on specific work exposures and without question, there is variability in exposures within occupational groups assigned; this would, in all likelihood, have muted the magnitude of differences we saw. We also lacked information on psychosocial issues, such as job strain, that have been reported to influence the risk of injury, as well as restricted and lost workdays [Josephson et al., 1996; Krause et al., 2001]. In addition, we did not have information about secondary employment, or exposures outside of work at this medical center that may be common among the low-wage workers. Moreover, we did not have information about how job placement upon hiring was determined with respect to whether a worker's capabilities were matched with the physical demands of the job. Selecting an appropriate reference group for these analyses proved challenging. We chose to use workgroups whose rates of injury fell below a selected injury threshold ($\leq 1.0/100$ FTEs). This method has its limitations in that the reference group does not consist of one defined workgroup whose exposure can be compared to those in the high-risk workgroups.

Because we were concerned that race and gender reflected job exposure in this population, we chose to conduct stratified analyses by gender, and not adjust for race [Kaufman and Cooper, 2001; Messing et al., 2003]. With the large number of workgroups, even our large cohort did not lend itself to stratification by both gender and race which could have been enlightening.

This work also has a number of strengths. We had access to a large, well-defined, diverse cohort of health care workers including their reported MSK injury experiences and time at risk. The large sample size allowed us to examine changes in injury rates over time, as well as examine risk of injury among workgroups stratified by gender. We were able to identify smaller workgroups at risk, such as lab animal technicians, laundry workers, and medical supply assemblers, that would otherwise not be identified within a smaller time frame or work cohort. Moreover, we identified larger workgroups at risk that are not typically considered part of the health care team including housekeepers, dietary workers, skilled craft workers, and secretaries. The majority of these workers (74%) have health insurance coverage through the medical center, removing concerns about differential influence of access to private medical care on reported work-related conditions.

CONCLUSIONS

Differences alone in MSK injury and disorder rates between men and women or blacks and whites do not imply institutional inequity or lack of social justice. However, when workgroups are highly segregated by race and gender, differential risk associated with work tasks can contribute to disparities in health and they are worthy of further exploration. Within the context of employment in the health care industry, several of the physically demanding jobs identified as high risk for MSK injuries and disorders at this center have typically been held by women and black workers [King, 1992; Gluck and Oleinick, 1998; U.S. Department of Labor, 2005a].

A recent report demonstrated that an association between injury risk and socioeconomic status among hospital workers (as defined by job responsibilities and educational requirements for the job) was explained by differences in working conditions, with those in the lowest socioeconomic status categories having the greatest injury risk [d'Errico et al., 2007]. With this in mind, the requirement of low skills and/or education in the high-risk jobs identified in our study could limit job transfer or promotion opportunities for injured workers who are unable to return to work because of their MSK injury or disorder. Unlike nurses, who have the option to migrate from inpatient nursing units to other types of less physically demanding work environments; other, less-skilled workers, with limited education, have few options for job transfers or promotions within or outside of their occupation. The lack of options of a career ladder may place them at risk for injury because of sustained exposure, potentially exacerbating an already existing illness or injury, and limiting their modified work opportunities. Consequently, the negative financial, physical, and/or psychological consequences of MSK injuries and disorders among these low-skilled workers could be substantial [Dembe, 2001].

Despite findings from earlier surveillance studies that identified several of these workgroups as high risk [Jensen, 1986 in Kaplan and Deyo, 1988; Khuder et al., 1999; US DOL, 2005b], few epidemiologic studies have sought to identify specific work-related risk factors of injury, let alone evaluate injury prevention strategies. Some workgroups, such as lab animal technicians are unique to medical centers with research laboratories; however, other workgroups such as housekeepers, dietary service workers, and laundry workers are universally represented across the health care industry, yet the research literature examining their work-related MSK injury risk factors is sparse. Even within the nursing literature, risk factors specific to nurses' aides, whose jobs are more physically demanding compared to nurses [Videman et al., 1984; Spilsbury and Meyer, 2004], have received little attention.

The paucity of studies in the literature possibly echoes the lack of attention that the health care industry has paid to

some of these workgroups with regard to protective workplace policies and prevention strategies. In recent years, the health care industry has sought to outsource some of its more physically demanding jobs, such as laundry workers [Moon, 2004] (which occurred at this medical center during the study period). Outsourcing not only perpetuates the lack of attention that these high-risk workgroups need, but it removes them from the surveillance system and from the occupational health and safety infrastructure within a medical center.

Injury experiences varied substantially among the employees of this large tertiary care medical center, largely reflecting differences in job exposures. With this in mind, prevention strategies need to be developed and tested specific to the demands of each workgroup. The growing interest in the use of patient lift equipment to prevent injuries among nursing personnel, internationally, as well as at this particular medical center, is very appropriate based on the size of the population at risk. The shift to using mechanical devices from brute strength has already demonstrated some success [Evanoff et al., 2003; Chhokar et al., 2005]; however, there is a marked lack of information about successful injury prevention strategies and return-to-work programs for other workgroups such as housekeepers, whose injury rates are on the rise in this cohort. These surveillance data provide background injury rates which can be useful with evaluating the effectiveness of future injury prevention intervention programs among these workgroups. Although the greatest public health impact will be achieved by focusing injury prevention strategies on large, high-risk workgroups including housekeepers, as well as secretaries, who had lower rates of injury, but a high number of lost workdays in our study; smaller, highly segregated workgroups should not be ignored.

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