

The Effect of Ergonomic Interventions in Healthcare Facilities on Musculoskeletal Disorders

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Background *The high incidence of musculoskeletal disorders (MSDs) among healthcare workers suggests that the introduction of ergonomic interventions could be beneficial. While laboratory studies have clearly documented the efficacy of ergonomic devices, few studies have examined their effectiveness in the healthcare workplace.*

Methods *This study evaluated a statewide program that provided ergonomic consultation and financial support for purchasing ergonomic devices, which aid in patient handling and lifting. Changes in MSD rates between baseline (1 year pre-intervention) and post-intervention (up to 2 years) periods were examined in 100 work units in 86 healthcare facilities.*

Results *The median MSD rate decreased from 12.32 to 6.64 per 200,000 employee-hours, a decrease greater than the secular trend for the study period (1999–2003).*

Conclusions *This study suggests that ergonomic consultation and financial support for purchasing ergonomic equipment can be an effective intervention to reduce MSDs among healthcare workers.* Am. J. Ind. Med. 48:338–347, 2005. © 2005 Wiley-Liss, Inc.

KEY WORDS: *intervention effectiveness; healthcare workers; prospective study; patient handling; lifting*

INTRODUCTION

Work-related injuries in healthcare facilities are highly prevalent. In the US in 2002, 12.6 occupational injuries or illnesses occurred per 100 full-time employees in nursing homes. [Bureau of Labor Statistics, 2003]. This is comparable to the injury rates in high-risk industries such as

construction and agriculture. The Occupational Safety and Health Administration (OSHA) released the first US guidelines for reducing risks for injury in nursing homes in March 2003 [Occupational Safety and Health Administration, 2003]. A majority of the injuries and illnesses among healthcare employees affect the back and shoulders [Bureau of Labor Statistics, 2003].

Epidemiological studies indicate that patient-handling tasks (e.g., transferring patients from a bed to a chair, helping patients bathe) are associated with a high incidence of injuries among nursing personnel [e.g., Garg et al., 1991, 1992; Yassi et al., 1995; Smedley et al., 1997; Marras et al., 1999; Engkvist et al., 2001]. In a large case-control study, Engkvist et al. [2001] found that regular patient transferring and the absence of assistive devices were associated with back injuries among nursing personnel. In a 2-year prospective cohort study of more than 900 hospital nurses, Smedley et al. [1997] found that among nurses who performed patient transfers without assistive devices, the

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likelihood of having back pain increased as the frequency of patient transfers increased.

Biomechanical studies have confirmed the link between patient transfer tasks and back injuries. Garg et al. [1992] estimated that compression forces to the back created by patient transfer activities exceed the tolerance limit established by National Institute for Occupational Safety and Health [1992]. While the results of Garg et al. [1992] were estimations from videotapes of employees in the workplace, Marras et al. [1999] conducted a laboratory study that assessed the force to the spine resulting from various patient-handling tasks using lumbar motion monitors directly on participants. They confirmed that patient-handling tasks are high risk for low back disorders, even when two people are handling the patient. These findings, both from the field and laboratory, suggest that patient-handling tasks create a high risk for back injuries.

A number of laboratory studies have assessed the efficacy of ergonomic devices designed to reduce exposure to lifting heavy weight [e.g., Elford et al., 2000; Silvia et al., 2002; Schibye et al., 2003; Zhuang et al., 1999]. Using lumbar motion monitors, Elford et al. [2000] found that even using a simple device (i.e., a sling) while transferring patients considerably reduced spinal loads. Zhuang et al. [1999] compared five patient transfer devices—three types of lifts, a sliding board, and a walking belt—with conventional manual transfers. They found that the three types of lifts reduced spinal loads by two-thirds. These studies have clearly shown that using assistive devices reduces spinal loads.

As described above, the efficacy of different ergonomic devices (i.e., the device's potential to reduce the compression force to the spine) has been demonstrated in controlled environments. However, evidence for the effectiveness of these devices in workplaces is scarce. Effectiveness refers to the actual decrease in injuries resulting from introducing ergonomic devices into healthcare settings. In their extensive review, Westgaard and Winkel [1997] found only one such study conducted between 1966 and 1994. In this study, Garg and Owen [1992] conducted an intervention in a nursing home, introducing mechanical hoists, walking belts, and shower chairs as well as providing on-site training. This intervention was based on their previous evaluation studies, which identified the most physically demanding patient-transfer tasks [Garg et al., 1992] and determined appropriate ergonomic devices to reduce the physical demands from these tasks [Garg et al., 1991a,b]. In Garg and Owen [1992] intervention study, injury rates decreased from 87 to 47 per 200,000 employee-hours in 4–8 months.

Evanoff et al. [2003] conducted an intervention study similar to that of Garg and Owen [1992], but on a larger scale. In 36 units from 9 healthcare facilities, they introduced mechanical lifts and provided a 2-hr training session. The intervention was associated with a 12% decrease in injury rates. In another study, Owen et al. [2002] conducted a 5-year

follow-up among hospital nurses who worked in units that installed five types of patient transfer devices. Injuries decreased from pre-intervention (20 injuries over an 18-month period) to post-intervention (26 total injuries over 5 years).

Recently, the State of Washington undertook a statewide intervention to reduce low back and shoulder injuries among nursing assistants in nursing homes [Silverstein et al., 2003]. The intervention focused on providing financial incentives from workers' compensation for installing lifting equipment. The investigators concluded that financial incentives served as a catalyst for obtaining ergonomic devices, but the one-time incentive did not have a sustainable impact on reducing injuries in nursing homes, especially in the context of high rates of employee turnover and frequent management changes [Silverstein et al., 2003].

The current study builds on these previous studies. The purpose of this study is to examine the effectiveness of ergonomic interventions to reduce musculoskeletal disorders (MSDs) among healthcare workers. The inclusion of a large number of healthcare facilities provides the opportunity for improved statistical rigor and enhanced generalizability of the results.

MATERIALS AND METHODS

Study Design and Settings

This is a prospective intervention study of 86 healthcare facilities in Ohio: 73 nursing homes (84.9%), 10 MR/DD facilities (11.6%), and 3 hospitals (3.5%). These facilities were located throughout the state of Ohio, in both urban and rural areas. Most of the facilities were privately funded.

Among the 86 facilities participating, 75 facilities had only one work unit potentially affected by the ergonomic intervention. Eleven facilities had more than one work unit (25 work units in total) where interventions were mounted. Since baseline MSD rates (calculations explained below) of the work units from the same facilities were not correlated ($r = 0.04$, $P = 0.92$), all 100 work units were treated as independent in data analysis. The 100 work units consisted of 85 nursing home units, 11 MR/DD facilities, and 4 hospital work units.

Intervention

A statewide ergonomic intervention, the Safety Grants Program (Program hereafter), was provided by the Ohio Bureau of Workers' Compensation (BWC). The Program offered financial support and ergonomic consultation to facilities for installing ergonomic devices to reduce the risk of work-related MSDs¹. The facilities were required to demonstrate the need for ergonomic intervention by

¹ For more detailed description of the BWC Safety Program, see <http://www.ohiobwc.com/employer/programs/safety/EmpGrants.asp>.

reporting baseline injury rates (based on the OSHA log) and to identify ergonomic interventions to reduce the incidence of MSDs. BWC ergonomists would then provide consultation and guidance to the facility. They visited the facilities after the equipment was installed in order to provide technical assistance and problem-solving support. During the visit, the ergonomist used a checklist to assess compliance with the Program requirements such as documenting the purchase of equipment and participating in a training session on how to report injury data (described below). The checklist also addressed problems that the facilities had encountered regarding actual use and maintenance of the equipment. This checklist was then used by the ergonomist to work together with the facility in improving use of the equipment and compliance with the Program.

Data Collection

Data were collected from the OSHA log by a designated staff member from each facility, typically the administrator or director of nursing. These staff members participated in a 4-hr training session taught by the BWC ergonomics technical advisor. They were given reporting forms and

instructed to report MSDs that had occurred only in the work unit(s) where the intervention was to be implemented. The reporting form asked about the total number of MSDs and the total number of employee-hours worked during the reporting period. For each case of MSD, the part of the body injured was also recorded. All MSD cases and the total employee-hours in the work unit were retrospectively reported for 1 year before the installation of the equipment (baseline data) and then reported every 6 months for up to 2 years after the installation (follow-up data). Facilities entered the study on a rolling basis between January 1998 and May 2001.

Statistical Analysis

Data were analyzed at the work-unit level ($n = 100$). The outcome variable is the MSD rate per 200,000 employee-hours worked (MSD rate = (the number of MSDs/employee-hours worked) \times 200,000). Since the distribution of the MSD rate was highly skewed, nonparametric tests were used to examine the statistical significance of the differences between baseline and follow-up MSD rates.

TABLE I. Descriptive Statistics for the Length of Observation, Employee-Hours Worked, Number and Rate of MSDs Per Work Unit, and Number of FTEs in Work Unit; Ohio Healthcare Facilities

Length of observation (in days)	Number of work units (n = 100)	Range (in days)		
Baseline				
Less than 1 year	3			334–343 days
1 year	90			360–366 days
More than 1 year	7			372–492 days
Follow-up				
1 year	5			348–368 days
More than 1 year, less than 2 years	22			385–714 days
2 years or more	73			727–837 days
	25%	Percentile 50% (Median)	75%	Range
Number of all MSDs				
Baseline (334–492 days)	2	5	10	0–50 ^b
Follow-up (348–837 days)	1	5.5	14	0–65
Employee-hours				
Worked per year	47,972	90,617	149,966	3,444–564,969
MSD rate				
Baseline	5.24	12.32	22.35	0–87.59
Follow-up	1.32	6.64	13.01	0–59.51
FTEs in work unit (approximation) ^a	16.43	31.03	51.36	1.18–193.48

N = 100.

^aCalculated as (employee-hours worked per year/365 days)/8 hr.

^bTwelve work units had no MSDs during the baseline observation.

TABLE II. MSD Rates^a and the Number of Work Units With Decreased, Increased, and Unchanged MSD Rates at Follow-Up

Type of intervention	n	MSD rate per work unit							
		Baseline		Follow-up		Change in MSD rates from BL to F/U (work unit)			
		Median	Range	Median	Range	Decreased or no change ^c	Increased	P-value ^d	Median rate ratio ^e
Reduction of bending	16	9.89	0.00–42.65	6.65	0.00–59.51	12 (75.0%)	4 (25.0%)	0.087	0.66
Elimination of lifting	44	15.38	0.00–87.59	9.25	0.00–28.27	32 (72.7%)	12 (27.3%)	<0.001	0.54
Reduction of carrying	8	6.47	0.00–15.80	0.33	0.00–6.70	7 (87.5%)	1 (12.5%)	0.046	0.15
Multiple interventions	32	11.98	0.00–60.34	7.78	0.00–25.94	26 (81.3%)	6 (18.7%)	0.001	0.56
All interventions	100	12.32	0.00–87.59 ^b	6.64	0.00–59.51	77 (77.0%)	23 (23.0%)	<0.001	0.52

^aMSD rate = (the number of MSDs/employee-hours worked) × 200,000.

^bTwelve work units did not have any injuries during the baseline data collection.

^cNo change: the MSD rate was zero for both baseline and follow-up.

^dWilcoxon Signed Ranks test.

^eRate ratio = (FU MSD rate)/(BL MSD rate).

RESULTS

Overall Comparison of Baseline and Follow-Up MSD Rates

Descriptive statistics for the 100 work units are presented in Table I. Because of the highly skewed distributions, the range and quartile values are reported instead of the mean and standard deviation. As an approximation of the work unit size, the daily average employee-hours divided by 8 was calculated. Of the 100 work units, 97 had at least 1 year of baseline. The three remaining work units reported 11 months of baseline. At the time of this study, nearly three-quarters of all work units (73 work units) completed 2 years of follow-up data collection. Of the 100 work units, 12 observed no MSDs during the baseline period. For these work units, the goal of the intervention was to maintain the zero MSD rate. MSD rates per 200,000 hr worked (100 full-time equivalent workers (FTEs)) varied considerably among work units.

There was no significant association between facility type (i.e., nursing home, hospital, and MR/DD) and change in MSD rates ($\chi^2 = 0.31$, $df = 2$, $P = 0.86$). Therefore, we analyzed the data from different facilities together.

The interventions were categorized into three types according to the potential benefit to the employees: reduction of bending (e.g., adjustable bed), elimination of lifting (e.g., patient lift), and reduction of carrying (e.g., transfer chair). The analysis comparing the effectiveness of the different types of interventions focused on these three types and on work units that were exposed to multiple interventions (i.e., any combination of the three types). Sixteen work units received interventions to reduce bending, 44 interventions to

eliminate lifting, 8 interventions to reduce carrying, and 32 multiple interventions.

Work-unit MSD rates are presented by different types of intervention in Table II. Median MSD rates decreased from baseline to follow-up for all intervention types. Table II also shows the number of work units with a decrease or no change in MSD rates as well as the number of work units with an increase. Overall, 77 work units experienced a decrease in the MSD rates or maintained zero MSD rate during the follow-up period ($Z = -5.73$, $P < 0.001$). More work units had decreased rather than increased MSD rates across all types of interventions.

The 77 work units that experienced a decrease in MSD rates and the 23 work units that had an increase in MSD rates were compared in terms of baseline MSD rates, work unit size (approximated by daily average employee-hours divided by 8), and the length of follow-up observations. Compared to the work units with decreased MSD rates, the work units with increased MSD rates had a significantly lower median baseline MSD rates (5.15 vs. 15.80; $Z = -3.74$, $P < 0.001$) and a significantly higher median employee-hours worked (approx. 37.2 FTEs vs. 30.3 FTEs; $Z = -2.37$, $P = 0.02$). No significant difference was found in the length of follow-up observation (741 days vs. 730 days, $Z = -1.30$, $P = 0.20$).

To indicate the magnitude of decrease in the MSD rates, the MSD rate at follow-up was divided by the MSD rate at baseline resulting in a “rate ratio” for each work unit. As shown in Table II, the median rate ratio for all work units was 0.52. That is, the Program was associated with a median overall decrease in MSD rates of 48%. Among the different types of interventions, reduction of carrying appears to have the lowest median rate ratio (0.15). However, given the small number (i.e., 8), work units that received this type of

TABLE III. MSD Rates by Affected Body Part and the Number of Work Units With Decreased, Increased, and Unchanged MSD Rates at Follow-Up; Ohio Healthcare Facilities

Affected body part	Median MSD rate ^a		Change in MSD rates from BL to F/U (work unit)			Median rate ratio
	Baseline	Follow-up	Decreased or no change	Increased	P-value ^c	
Back	6.88	3.02	79 (79.0%)	21 (21.0%)	<0.001	0.43
Other ^b	5.09	3.03	73 (73.0%)	27 (27.0%)	<0.001	0.51

N = 100.

^aMSD rate = (the number of MSDs/employee-hours worked) × 200,000.^bIncluding shoulder, upper and lower extremities, head, neck, trunk, and multiple body injuries not involving back.^cWilcoxon Signed Ranks test.

intervention, the median rate ratio may not be reliable. The difference in rate ratio among the different types of interventions was not statistically significant ($\chi^2 = 3.33$, $df = 3$, $P = 0.34$).

Change in MSD Rates by Affected Body Part

During 1 year of the baseline period, a total of 764 MSD cases were reported among the 102 work units. Of those, 435 cases (56.9%) involved the back, and the remaining 329 cases (43.1%) affected body parts other than the back. Other body parts included shoulder, upper and lower extremities, head, neck, trunk, and multiple body injuries that did not involve the back. Since the interventions were predominately targeted to reduce back injuries, the change in back injury rates was compared to the change in rates of injury to other parts of the body. Table III presents the median MSD rates by affected body part as well as the number of work units with decreased or no change and increased MSD rates by affected body part. Decreases in back MSD rates and other MSD rates

are both associated with the intervention ($Z = -5.45$, $P < 0.001$; $Z = -3.84$, $P < 0.001$, respectively).

As shown in Table III, the median MSD rates decreased for both the back and other body parts, and more than 70% of the work units experienced a decrease or no change in each type of MSD rates. In order to examine whether or not the work units with decreased back MSD rates were more likely to have increased MSD rates in other parts of the body, a Chi-square test of homogeneity was conducted (Table IV). The result showed no relationship between change in back MSD rates and change in non-back MSD rates. ($\chi^2 = 1.66$, $df = 1$, $P = 0.20$).

Change in MSD Rates Over Time

Among the 100 work units, 73 provided 1 year of baseline data as well as follow-up data for a full 2 years. To indicate the change in the MSD rates from baseline through the 2-year follow-up period, back- and non-back MSD rates were calculated for each of the four 6-month reporting intervals. For MSDs affecting the back, the rate at baseline was 7.70. At the 6-month, 12-month, 18-month, and 24-month follow-ups, the back MSD rates were 5.61, 4.58, 3.84, and 3.54, respectively. For MSDs that involved body parts other than the back, the baseline MSD rate was 6.07. At the 6-month, 12-month, 18-month, and 24-month follow-ups, the non-back MSD rates were 5.17, 5.53, 3.94, and 3.27, respectively. Figure 1 presents the gradual decline in both back- and non-back MSD rates across the 2-year follow-up period.

The Friedman test, a nonparametric analog for repeated measures, showed significant differences among the four back MSD rates in the follow-up period ($\chi^2 = 9.88$, $df = 3$, $P = 0.02$). Although the Friedman test does not allow us to determine where exactly the significant difference exists, Figure 1 suggests that the back MSD rate during the first 6 months of follow-up is higher than the rates during the second year. The MSD rates for body parts other than the back did not

TABLE IV. Number of Work Units With Different Outcomes in Back MSD Rates and in MSD Rates in Other Parts of the Body^a

Non-back MSD rate	Back MSD rate			Total
	Decreased or no change	Increased		
Decreased or no change	60 (75.9%)	13 (61.9%)	73 (73.0%)	
Increased	19 (14.1%)	8 (38.1%)	27 (27.0%)	
Total	79 (100.0%)	21 (100.0%)	100 (100.0%)	

Ohio healthcare facilities.

($\chi^2 = 1.66$, $df = 1$, $P = 0.20$).^aOther parts of the body include shoulder, upper and lower extremities, head, neck, trunk, and multiple body injuries not involving back.

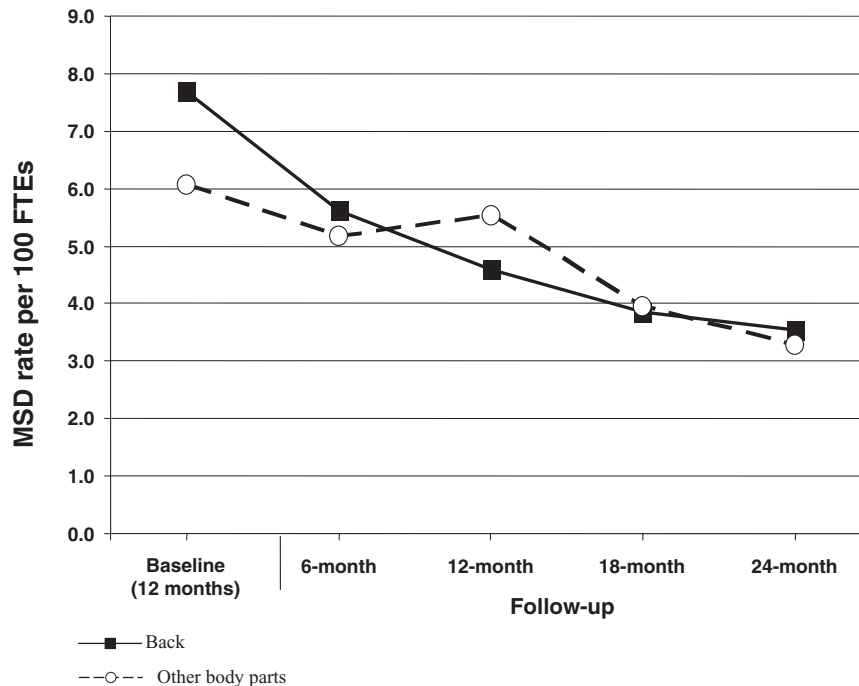


FIGURE 1. Change in MSD rates over time by affected body part in Ohio healthcare facilities.

differ significantly over the four reporting periods ($\chi^2 = 2.18$, $df = 3$, $P = 0.54$).

Comparison With National Data

The secular trend in injury rates during the Program period was examined using Bureau of Labor Statistics (BLS) data. The BLS data are based on injuries reported on the OSHA log, as are the data in this study. The BLS occupational category most similar to the study sample is the employees of nursing homes and residential care facilities (NAICS code 623). In order to make our data more comparable to the BLS data, in this comparison we used data only from nursing homes, which represent 85% of the study sample. While our data include only MSDs, MSDs accounts for a vast majority (86%) of non-fatal injuries in nursing homes [Bureau of Labor Statistics, 2003]. Although the incidence rates for all injuries in BLS data are expected to be slightly higher than the MSD rates in this study, the two sets of data are reasonably comparable.

The baseline data were reported before interventions for a 1-year period. Then each work unit reported its employee-hours worked and MSD cases every 6 months for 2 years. These reports were categorized by the year in which baseline data were reported. Of the 85 work units in nursing homes, 52 work units reported their baseline data in 1999, 26 in 2000, and 7 in 2001. The MSD rates for each baseline year group are shown in Figure 2 on the three solid lines. The BLS injury

rate for all OSHA recordable injuries in nursing homes is shown on the dotted line.

The baseline MSD rates in this study were similar to the BLS rates in the corresponding years. However, the follow-up MSD rates were considerably lower than the BLS rates. From 2000 to 2003, the BLS data showed a slight decline, but the decline in MSD rates observed in this study exceeded the magnitude of the decline exhibited in the BLS data and preceded the BLS decline in terms of timing.

Potential Confounders

Two potential confounders were examined: different length of observation at follow-up and size of the work unit. Because some work units had not completed their full 2 years of follow-up reporting at the time of this study, work units included in this study had different lengths of observation in follow-up. Since OSHA recordable MSDs are relatively a rare event, the longer the observation period, the more likely it might be for the work unit to have incident MSD cases. Thus, work units with a shorter follow-up observation period might appear as having a lower MSD rate than the work units with longer follow-up. On the other hand, as shown above, the MSD rates declined over time among the sub sample of 73 work units with complete follow-up observation. This suggests that the shorter the follow-up observation, the higher the follow-up MSD rate. To examine the possibility that the length of follow-up influenced the observed change

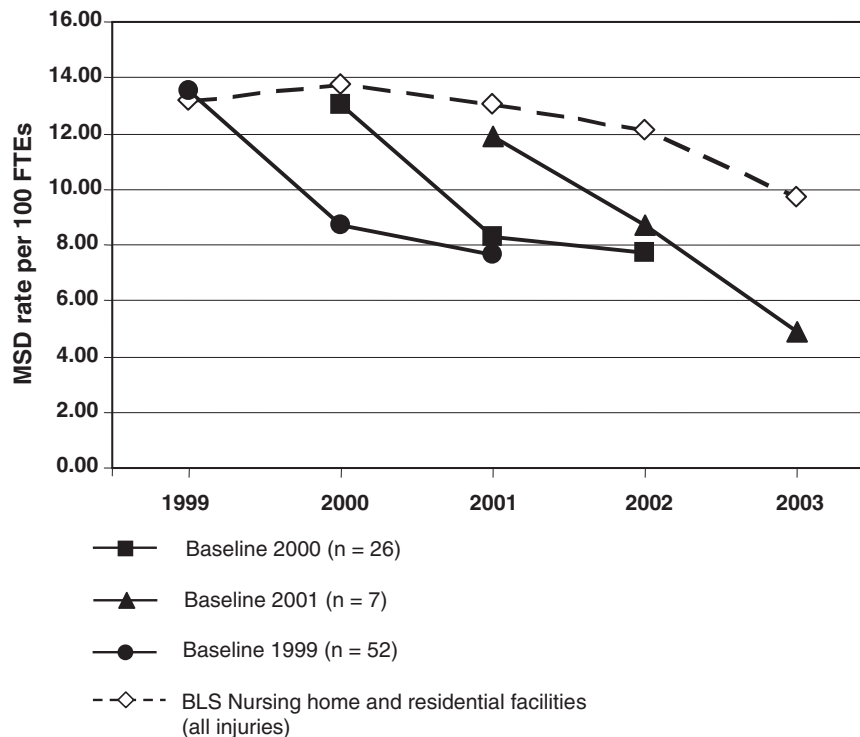


FIGURE 2. Comparison of study results with BLS data for injuries sustained in Ohio nursing homes.

in MSD rates, the number of days observed in the follow-up period was correlated with the MSD rates in follow-up. This correlation was very small (Spearman's $r = -0.03$, $P = 0.79$), suggesting that different lengths of observation in follow-up had no influence on change in MSD rates.

The relationship between a work unit's change in MSD rates from baseline through follow-up and the size of the work unit was explored. For each work unit, an approximation for the number of FTEs was calculated as the daily average number of employee-hours divided by 8 (i.e., an 8-hr working day). This approximation for FTEs was used as an indicator for work unit size. The 100 work units were divided into quartiles by FTEs (up to 16, 17–31, 32–51, 52 and greater). Change in MSD rates was compared across the four groups. The median rate ratios were, from the smallest to largest FTE group, 0.29, 0.55, 0.66, and 0.78 respectively. The differences among the four groups were significant ($\chi^2 = 15.46$, $df = 3$, $P = 0.001$), suggesting that the smallest work units had a greater decrease in MSD rates than the larger ones. To examine the possibility that this difference might be due to regression toward the mean, the baseline MSD rates were compared among the four groups. The median baseline MSD rates are, from the smallest to largest FTE group: 9.51, 16.09, 10.91, and 9.81. Although the difference in the baseline MSD rates among the four groups was marginally

statistically significant ($\chi^2 = 6.22$, $df = 3$, $P = 0.10$), the pattern does not support a regression to the mean explanation.

DISCUSSION

Overall Effectiveness

This study evaluated the effect of a statewide ergonomic intervention program on MSD rates among employees among healthcare facilities. The interventions provided through this program were associated with decreased MSD rates. Comparisons among different types of interventions (i.e., reduction of bending, elimination of lifting, reduction of lifting, and a combination of the three) showed that each type of intervention was associated with decreased MSD rates.

The magnitude of association did not differ among the different types of intervention. This finding is not consistent with a recent comprehensive review of job-related MSD research [Panel on Musculoskeletal Disorders and the Workplace, Commission on Behavioral and Social Sciences and Education, National Research Council, Institute of Medicine, 2001] that concluded that multi-component interventions are more effective than single interventions. In addition, elimination of lifting was expected to have a stronger association with decreased MSD rates than reduc-

tion of lifting or bending. However, our data did not support this. One potential explanation is that intervention itself, regardless of its mechanical benefit to the body, helped raise awareness for safety procedures in patient handling among employees. This raised awareness may have changed their daily practice, which may have led to lowered MSD rates.

While more than three-quarters of the work units experienced a decrease in MSD rates after interventions were implemented, there were 23 work units that experienced an increase in MSD rates. The work units with an increased MSD rate had lower baseline MSD rates and were larger in size. These findings suggest that it is difficult to reduce MSD rates when the incidence is already low. The low MSD rates at baseline may have reflected previous efforts by the work units to reduce work-related injuries. In order to make MSD rates even lower, intervention may need to be more intensive and tailored to specific work units.

Exploring the influence of potential confounders suggested that the size of the work unit was associated with the change in MSD rates before and after the ergonomic equipment was installed. Small work units (with up to 16.4 FTEs) had the greatest reduction in MSD rates. This reduction is unlikely to reflect regression toward the mean since the baseline MSD rates for the small work units were not higher than that of the larger work units. Instead, this may have reflected the employee-to-ergonomic device ratio. Because the grant fund was up to \$40,000 regardless of the size of the work unit, most of the work units purchased at least \$40,000 worth of equipment so that they could take full advantage of the Program. This could have resulted in lower employee-to-ergonomic device ratios in smaller facilities, assuming each work unit acquired more or less the same number of devices. This may explain a better outcome in smaller work units.

In the SHARP Program in the State of Washington, the opposite relationship between the size of the facility (indicated by the number of beds) and intervention effectiveness was found; the smaller the facility, the more likely to have a higher claim rate [Silverstein et al., 2003]. This appears contradictory to our finding of better outcomes in smaller work units, but it could be due to a difference in the magnitude of financial support provided to the participating facilities. In the SHARP Program, a 15% discount in workers' compensation premium was offered to the facilities with an agreement that the premium discount was to be spent on purchasing ergonomic equipment. Workers' compensation premiums are generally calculated based on the size of the payroll, which is relative to the size of the facility, and modified based on each facility's previous 3 years' experience with workers' compensation claims. Although the amount of modification may vary among facilities, if we assume similar claim history among the facilities that participated in the SHARP Program, the actual amount of money available for the purchase was relative to the size of

the facility. The smaller facilities in the SHARP Program had less purchasing power and may not have been able to purchase enough ergonomic devices to actually reduce the risk for MSDs.

While back-MSDs are the most common type of injury among healthcare employees, the back should be considered in relation to the rest of the body. De Looze and colleagues [2001] pointed out that interventions that decrease injuries to one part of the body may increase injuries to other parts of the body. In our study, most of the intervention equipment was intended to reduce back injuries. However, no increase in rates of MSDs affecting other body parts was observed. Thus, in our data, no evidence for injury trade off was found.

Change in MSD Rates Over Time

The change in MSD rates over time was documented by a sub-sample of 73 work units that had 2 full years of follow-up data. This data suggests that, after the introduction of the ergonomic intervention, the MSD rates gradually declined over the 2-year period, rather than decreasing right after the intervention. The cumulative nature of MSDs may explain this time lag. MSD rates observed earlier in the follow-up period may have reflected cumulative exposure prior to the intervention. Those employees who had been exposed to heavy physical loads before the intervention may have manifested their injuries during the first year after the intervention. With the introduction of the patient transfer aid or lifting device, exposure to high spinal loads was likely reduced. For those employees whose pre-intervention exposure was severe enough to lower the threshold for manifesting MSDs, the reduced exposure to high spinal load may still have triggered MSDs after the intervention. However, for employees whose pre-intervention exposure was not as severe, the reduced exposure made it possible for them to avoid MSDs. In addition, new employees hired after the intervention were exposed to lower physical loads and thus were less likely to develop MSDs. The MSD rates, later in the follow-up period, would incorporate these new employees' injury rates. Given the high turnover rates in healthcare facilities in general [Centers for Medicare and Medicaid Services, 2002], this seems a plausible contributor to the continuing decline in injury rates a year after the introduction of the intervention.

Limitations and Conclusion

This study has a number of strengths. The sample size allowed us to examine the results across facilities rather than individuals. The participating facilities were diverse in type, size, and location. Also, the injury data were collected repeatedly over a 2-year span of follow-up. All these characteristics enhance the utility and generalizability of our findings.

This study also has several limitations. First, no control group was available. Instead, we compared the injury rate results of the intervention work units with the most comparable data from the BLS for the same period. Even though the national data indicated a descending trend in MSDs of the back, the decrease in back disorder rates observed in the study preceded the national trend.

Second, although ergonomic expertise was available from the BWC, the experts were not always highly involved in identifying the most appropriate interventions for individual work units. The facilities were required to identify ergonomic devices they needed and provide a rationale for the potential efficacy of the devices chosen. However, this was not always done by qualified ergonomic experts. Had BWC ergonomists been more actively involved in the development of every intervention, the program would have been even more effective.

The extent to which the ergonomic devices were utilized appropriately was not measured. The cost of training employees on the use of new equipment was budgeted and supported by the Program, and consultation with BWC ergonomists was available for the facilities at no additional charge. Thus, the Program encouraged facilities to provide training to employees and obtain technical support. After installing the equipment, every facility received at least one follow-up visit by Program staff. During the visit, the Program ergonomist observed the use of the equipment. In the cases where equipment was not appropriately or fully utilized, the ergonomist worked with management to identify and overcome technical or cultural obstacles. Anecdotal data from these visits suggested that the equipment was being used, but systematic information on the actual use of each device is not available. Previous studies have reported low rates of use of newly installed equipment [Garg and Owen, 1992; Evanoff et al., 2003]. Because compliance data are not available in this study, differences in effectiveness due to different levels of compliance could not be examined. Future studies should consider whether levels of compliance change over time, and if so, the extent to which these changes are reflected in MSD rates.

Lastly, the generalizability of the findings may be limited due to the fact that all of the participating worksites self-selected themselves into the safety grant program. These worksites are likely to be more motivated to enhance employee safety than the average healthcare facility.

Despite these limitations, this study demonstrates that financial support for acquiring equipment to assist with patient-handling and transfer tasks can be associated with substantially decreased MSD rates. Hignett [2003], in her recent review of ergonomic intervention studies, stated that equipment provision has the potential to be the most cost-effective intervention for reducing injuries in healthcare facilities. Although a formal cost-effectiveness analysis could not be conducted in this study, our findings clearly

show that providing equipment was associated with decreased MSD rates throughout the 2-year follow-up period.

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