Impact of Publicly Sponsored Interventions on Musculoskeletal Injury Claims in Nursing Homes

Robert M. Park, MS,[1]* P. Timothy Bushnell, PhD, MPA,[2] A. John Bailer, PhD,[1,3] James W. Collins, PhD,[4] and Leslie T. Stayner, PhD[5]

Background *The rate of lost-time sprains and strains in private nursing homes is over three times the national average, and for back injuries, almost four times the national average. The Ohio Bureau of Workers' Compensation (BWC) has sponsored interventions that were preferentially promoted to nursing homes in 2000–2001, including training, consultation, and grants up to $40,000 for equipment purchases.*

Methods *This study evaluated the impact of BWC interventions on back injury claim rates using BWC data on claims, interventions, and employer payroll for all Ohio nursing homes during 1995–2004 using Poisson regression. A subset of nursing homes was analyzed with more detailed data that allowed estimation of the impact of staffing levels and resident acuity on claim rates. Costs of interventions were compared to the associated savings in claim costs.*

Results *A $500 equipment purchase per nursing home worker was associated with a 21% reduction in back injury rate. Assuming an equipment life of 10 years, this translates to an estimated $768 reduction in claim costs per worker, a present value of $495 with a 5% discount rate applied. Results for training courses were equivocal. Only those receiving below-median hours had a significant 19% reduction in claim rates. Injury rates did not generally decline with consultation independent of equipment purchases, although possible confounding, misclassification, and bias due to non-random management participation clouds interpretation. In nursing homes with available data, resident acuity was modestly associated with back injury risk, and the injury rate increased with resident-to-staff ratio (acting through three terms: RR = 1.50 for each additional resident per staff member; for the ratio alone, RR = 1.32, 95% CI = 1.18–1.48). In these NHs, an expenditure of $908 per resident care worker (equivalent to $500 per employee in the other model) was also associated with a 21% reduction in injury rate. However, with a resident-to-staff ratio greater than 2.0, the same expenditure was associated with a $1,643 reduction in back claim costs over 10 years per employee, a present value of $1,062 with 5% discount rate.*

Conclusions *Expenditures for ergonomic equipment in nursing homes by the Ohio BWC were associated with fewer worker injuries and reductions in claim costs that were similar in magnitude to expenditures. Un-estimated benefits and costs also need to be considered in assessing full health and financial impacts.* Am. J. Ind. Med. 52:683–697, 2009. *© 2009 Wiley-Liss, Inc.*

KEY WORDS: certified nursing aide; consultation; ergonomics; injury costs; resident acuity; staffing ratio; training courses

[1]Education and Information Division, National Institute for Occupational Safety and Health, Cincinnati, Ohio
[2]Division of Surveillance, Hazard Evaluation and Field Studies, National Institute for Occupational Safety and Health, Cincinnati, Ohio
[3]Department of Statistics, Scripps Gerontology Center, Miami University, Oxford, Ohio
[4]Division of Safety Research, National Institute for Occupational Safety and Health, Morgantown, West Virginia
[5]Department of Epidemiology, School of Public Health, University of Illinois at Chicago, Chicago, Illinois

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

*Correspondence to: Robert M. Park, National Institute for Occupational Safety and Health (NIOSH), Risk Evaluation Branch, 4676 Columbia Parkway, C-15, Cincinnati, OH 45226. E-mail: rhp9@cdc.gov

Accepted 8 June 2009
DOI 10.1002/ajim.20731. Published online in Wiley InterScience (www.interscience.wiley.com)

INTRODUCTION

Nursing home workers experience high rates of musculoskeletal injury due to frequent lifting and re-positioning of residents [Collins and Owen, 1996; Myers et al., 2002; Trinkoff et al., 2005]. In 2006, private nursing care facilities had lost-work-time sprains and strains over three times the national average (162 per 10,000 workers) and back injuries 3.9 times the national average (106 per 10,000 workers) [US Dept. of Labor (DOL), Bureau of Labor Statistics (BLS), 2008a; Table R5]. Nursing aides, orderlies and attendants, 37% of nursing home employees [US DOL, BLS, 2008b], are the main group responsible for direct care of residents [Myers et al., 2002]. Their rate of occupational back injuries and illnesses was 7.7 times the national average [US DOL, BLS, 2008a; Table R97]. One study estimated total injury and illness costs in nursing and personal care facilities, including medical costs, lost productivity at work and home, and estimates of personal suffering in terms of dollars, to be 1.9 billion dollars in 1993, or 2.7 billion in 2007 dollars[1] [Waehrer et al., 2005]. In addition, injuries may be contributing to staff turnover that on average exceeds 100% per year [Straker et al., 1997].

The Ohio Bureau of Workers' Compensation (BWC) sponsors interventions, including training, consultation and at the time of this study, grants up to $40,000 for equipment purchases [BWC, 2009a]. While available to all employers, these were preferentially promoted to nursing homes in 2000–2001. This study evaluated the impact of these interventions on back injury rates using administrative data for all Ohio nursing homes. Estimation of the influence of staffing levels and resident acuity on back injury rates was incorporated in the analysis for a smaller set of nursing homes.

METHODS

Injury rates were modeled as a function of prior interventions during the period 1995–2004, using Poisson regression and adjusting for potential confounding covariates. A BWC analysis data set was constructed by merging BWC datasets containing payroll, intervention, and claims data. A second analysis data set for a smaller set of NH was created by linking data from the first data set with data from the Online Survey Certification and Reporting (OSCAR) data file (see Fig. 1 for a flow chart of file construction). Costs of interventions were also compared to the cost savings associated with intervention impacts.

Claims and Employer Information

Information from BWC claims was provided without identifiers for all nursing-home employers in Ohio during the period 1995–2004 and included date of injury, brief description of injury event, assigned ICD-9 codes (up to 10), age, sex, employer ID, and costs: medical payments, indemnity payments (compensation for lost wages) and reserves set aside for anticipated future costs. Employer payroll and premium history was available in 6-month periods, classified in "manual codes" assigned to employers for risk classification purposes. Only claims and payroll history in the manual codes assigned for nursing homes were selected. Employers in the BWC system can encompass multiple facilities and locations so that payroll (size of workforce) does not necessarily pertain to individual facilities. An attempt was made to distinguish nursing homes from staffing agency employers that use some of the same manual codes by (1) reviewing employer name, and (2) examining the number of distinct manual code numbers for which an employer reported payroll. Staffing agencies were excluded from analyses (unless stated otherwise) because NH interventions could not be mapped to NH employees. During 1995–2004 some employers underwent acquisitions, mergers, or changes of ownership. Data for individual entities that later came to be insured together under a single policy were consolidated over the entire 10-year period. Eleven percent of final employers (110 of 1,028) had a history representing the aggregation or succession of two or more employers.

Definition of Interventions

The amount of intervention received prior to each month was computed. Separate, time-dependent measures were compiled: (a) consulting hours by category (ergonomics, industrial hygiene, safety, or other), (b) course hours—ergonomics or other (involving safety committees, investigations, record keeping, etc.), (c) total capital expenditures resulting from BWC grants for lifts, electric beds or other devices and employee training in their use (sometimes exceeding the $50,000 maximum eligible for an 80% BWC matching contribution) [BWC, 2009b], and (d) number of video training tapes loaned by the BWC to nursing homes related to ergonomics (based on title).

Measures of interventions for employers that resulted from a merger of component employers were derived in two ways. For interventions that should theoretically impact employees independent of employer size (consultation to management, course hours, and videos) the intervention measure of the merged entity was a sum of the component employer measures, weighted by the payroll shares of each component at the time of merger. This assumes that an intervention affects only the workforce receiving it, even after it is combined with another. By contrast, the impact of equipment expenditures, such as for lifts or electric beds, was assumed to depend on workforce size; the total prior aggregate expenditure over component workforces was

[1] The Consumer Price Index (all urban consumers) was used to convert 1993 dollars to 2007 dollars [US DOL, BLS, 2008c].

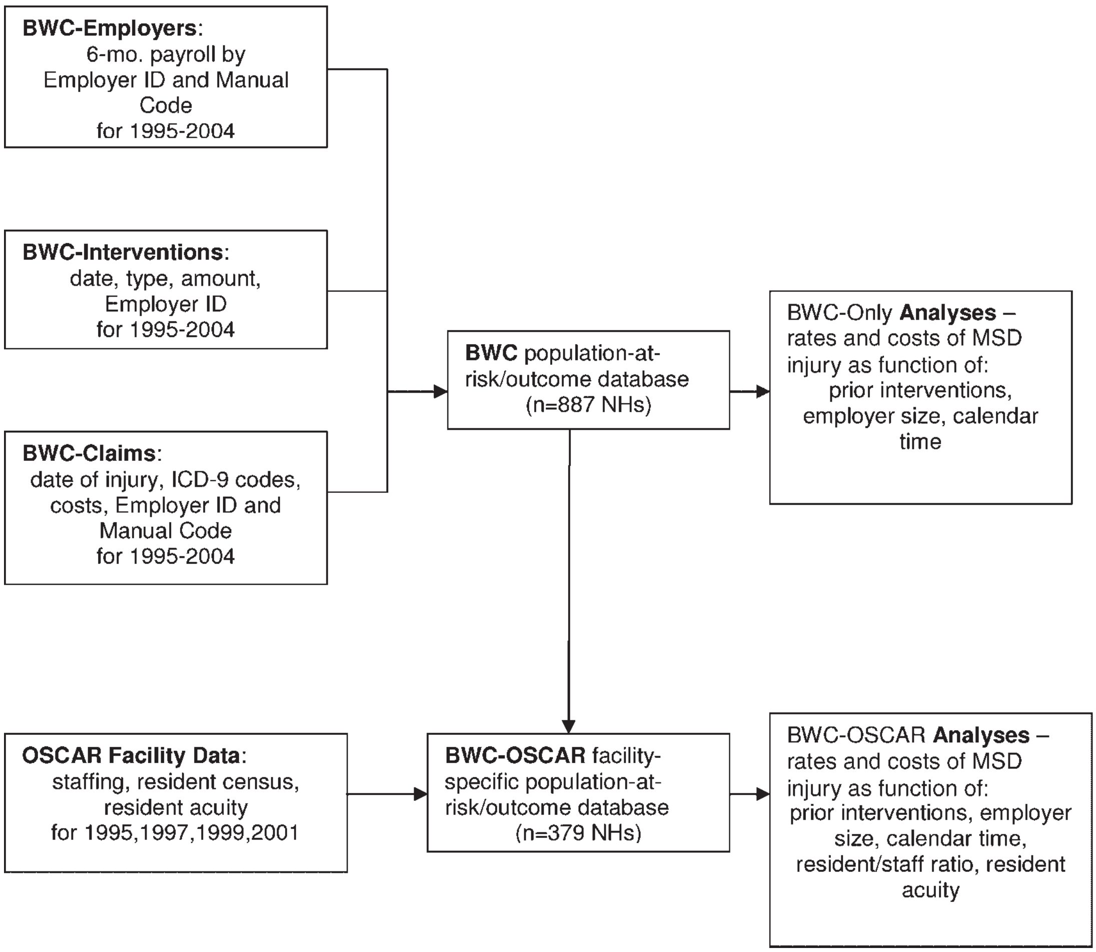

FIGURE 1. Construction of databases for modeling rates of musculoskeletal injury in nursing homes.

divided by the current aggregate workforce size to yield an average expenditure per worker.

Definition of Cases

Incident cases of musculoskeletal injury were defined as BWC-allowed claims with date of injury during 1995–2004 and with at least one ICD-9 diagnostic code for the specified injury site. All claims with a diagnosis code for back injury were classified as back claims, regardless of the presence of other diagnosis codes. To avoid double counting, other musculoskeletal disorder (MSD) claims were placed in mutually exclusive groups according to a hierarchy: back, shoulder, knee, elbow, neck. For example, a "knee" claim includes no back or shoulder injury, but may include an elbow or neck injury.

Facility-Specific Information

Facility-specific information (e.g., resident census, mean resident acuity, staffing information) from OSCAR, files maintained by the Centers for Medicare and Medicaid Services (CMS), as well as Ohio Department of Health surveys were obtained from the Scripps Gerontology Center of Miami University (Oxford, OH). Only *single-facility* BWC employers could be linked with facility-specific attributes (using facility name, address, and telephone) (Fig. 1). Resident/staff ratios were computed, counting only employees directly involved in resident handling: certified nursing aides, assistant physical therapists, assistant occupational therapists, and those in training (thus excluding RNs, dietary, laundry, custodial, and clerical).

Resident acuity metrics associated with higher likelihood of resident transfer tasks include the following [Cowles, 2002]:

(a) *ADL* (activities of daily living) *Index*—a weighted sum of proportions of residents with 12 specific functional impairments such as eating, dressing, etc.
(b) *ACU Index*—the sum of the ADL Index and five additional proportions (specific medical requirements such as intravenous therapy).

(c) *ADL Score* (0–5)—average number of ADL dependencies (bathing, dressing, etc.).
(d) *PROPAC*—estimates of minutes of care per day required by the resident based on nine resident attributes (Prospective Payment Assessment Commission).

Four hazard exposure metrics were defined as the product of the resident/staff ratio (RSR) and each of the four mean acuity measures (surrogates for the frequency of resident transfer tasks).

Analysis

Injury rates were calculated from BWC claims in relation to person-time of observation. Employer workforce was estimated in monthly intervals based on payroll reported semiannually, assuming an average annual income for nursing home workers of $18,000 in 1995 with a 3% annual increase.[2] Alternatively, for the OSCAR NH subset, the resident care staff defined the population at risk.

Injury rates were modeled using Poisson regression [Frome and Checkoway, 1985] as implemented by the EPICURE statistical package [Preston et al., 1993]. Predictor variables included intervention metrics, employer size, calendar time and, in some analyses, facility-specific injury risk factors. Model specifications were based on prior hypothesized effects and model fit. The unit of classification was one nursing home-month; the unit of analysis was one person-month of observation. The EPICURE system permits ''stratification'' on employer such that individual intercepts corresponding to ''baseline'' rates are calculated (but not displayed) for each employer, thus partially controlling for unknown employer-specific risk factors that are relatively constant over time.

The injury rate in the *k*th nursing home employer is modeled as:

$$
\begin{aligned}
\text{injury rate}_k = \exp[\alpha_k &+ \sum_{\text{sizes}} \beta_j \text{I(employer k} \in \text{size class j)} + \gamma \text{IP} \\
&+ \sum_{\text{interventions}} \delta_j \text{I(employer k has consult/training j)} \\
&+ \sum_{\text{interventions}} \varepsilon_j \text{I(employer k has consult/training j} > \text{median)} \\
&+ \phi\,\text{Video} + \omega \text{I(employer k has received Grants)} + \theta\sqrt{\text{Grant\$}}]
\end{aligned}
$$

where α_k are employer-specific intercepts; I(...) are various (0,1) indicators; IP is an index of 6-month time periods, 1,2,...20 beginning January 1, 1995; interventions j are types of consultation or training, Video is number of tapes loaned, and Grant$ is the cumulative expenditure for equipment per employee. The square root transformation of Grant$ permitted a declining benefit with incremental expenditure, which might occur if the problems most easily fixed are addressed first. It also yielded better fitting models. The estimated employer baseline reference injury rates ($\exp[\alpha_k]$) correspond to January–June 1995 with no prior intervention and size: 10–20 employees. Confidence intervals and hypothesis tests were adjusted for over-dispersion by using a heterogeneity factor: total model deviance divided by total degrees of freedom (expected to be ~1.0 without over-dispersion) [McCullagh and Nelder, 1983].

In analyses with facility-specific information, additional terms were included: resident/staff ratio (RSR) and the hazard exposure measures. Interaction terms were also included in some models. For example, the term $\sqrt{\text{Grant\$}} \times \text{I(size} = \text{j)}$ was used to examine size-specific effects of equipment expenditures and $\sqrt{\text{Grant\$}}(\text{RSR} > 2)$ was used to examine how staffing levels affected the impact of grants.

The coefficient of the indicator for receipt of any grant (ω) can be viewed in two ways. First, it may capture those parts of the effect of equipment purchase that vary little with its amount, such as those flowing from the policy, training and cultural change that may accompany the purchase. Second, this coefficient may capture selection differences between employers who elected to pursue grants and those who did not. There should be limited selection differences between employers with different (non-zero) amounts of equipment purchases per employee, because these amounts appeared to be much more strongly influenced by NH size than other characteristics, given the cap on grant amount. For the other interventions, indicator variable coefficients must be viewed as representing a combination of selection differences and effects of the interventions, holding other terms constant.

Logistic regression [Hosmer and Lemeshow, 1989; Preston et al., 1993] was used to examine whether a NH was more likely to use an intervention after BWC

2 These assumptions affect estimated claim rates and the time trend coefficient but do not affect relative risk estimates. Data on pay rates [US DOL, BLS, 2008d,e] suggests that the average pay of Ohio NH employees was about $18,600 in 1995 (at 2,080 hr/year) rising to about 28,800 in 2004, for an average annual rate of increase of almost 5%. However, the pay of direct care employees may have risen less rapidly because of widening differences between pay rates of employees with different levels of education.

implementation of the special emphasis program for nursing homes during 2000–2001. This model included injury rates prior to the year 2000 as a potential predictor variable. Multiple linear regression [Neter and Wasserman, 1974] was also used to examine whether the costs per claim depended on prior interventions, using the same set of independent variables that were used to model injury rates.

RESULTS

Descriptive Findings Based on BWC Information—All Employers

Back claim rates and trends

There were 1,028 ''ultimate'' or ''final'' employers with any NH payroll during 1995–2004 in Ohio. Some employers (n = 99) reported payroll corresponding to a workforce of 10 or fewer employees and had high rates of injury (>10 per hundred workers per year), suggesting payroll reporting errors, and were excluded. Also excluded were employers that appeared to be temporary staffing agencies (n = 42) resulting in 887 employers (representing years of operation equivalent to 642 NHs operating 10 years each) for which there were 654,292 person-years of observation (98% of total) and 23,724 back injuries for an overall rate of 3.6 per 100 workers per year (95% CI = 3.6–3.7; Table I). Among temporary staffing agencies, there were 410 back injuries during 1995–2004, with a rate of 2.8 per 100 workers (data not shown).

Among nursing home employers having stable, unique ownership over 1995–2004, the small to mid-size categories (21–100 employees) had higher rates (3.9 per 100 workers) relative to the smallest (3.4 per 100 workers) or largest (3.2 per 100 workers) size categories. Multiple employer nursing homes experiencing changes in ownership generally had higher rates than the single employer NHs of the same size, and these rates consistently declined from the smallest size (13.2) to the largest (3.6) (Table I).

Examining nursing homes in three time periods, 1995–1999, 2000–2001, and 2002–2004, reveals crude back injury rates of 3.67, 3.70, and 3.46 per hundred, respectively. There was no meaningful change during 2000–2001 relative to 1995–1999 (RR = 1.009, $P = 0.67$) while for 2002–2004, there was a statistically significant reduction in back injury rates (RR = 0.94, $P = 0.0002$).

Time trends in back injury rates over 1995–2004 were similar across size categories and declining for all but the smallest NHs. A Poisson model of rates over time was fit, estimating a single constant proportional rate of change. This procedure yielded predicted annual rates of decline ranging from 1.3% (size: 101–200) to 1.9% (size: 200+) per year for all except the smallest employers whose injury rates started out lower but doubled during 1995–2004. These findings are

TABLE I. Nursing Home Employers: Rates of Back Injury (Per 100 Workers Per Year), Cases, and Observation Time by Size of Estimated BWC-Covered Workforce, 1995–2004 in Ohio

Workforce size[a,b]	10–20	21–50	51–100	101–200	201+	All
All employers						
Rate (95% CI)	4.3 (3.9–4.7)	4.0 (3.9–4.2)	4.0 (3.9–4.1)	3.5 (3.4–3.6)	3.4 (3.3–3.5)	3.6 (3.6–3.7)
N, employers[c]	56.6	173.8	197.2	160.0	56.0	641.7
Average size	15.5	36.0	75.7	137.7	381.1	102.0
Total workforce (%)	878 (1.3)	6,255 (9.6)	14,929 (22.8)	22,039 (33.7)	21,328 (32.6)	65,429 (100.0)
Total cases	375	2,514	5,959	7,648	7,228	23,724
Total P-Yrs	8,781	62,553	149,288	220,389	213,282	654,292
Mean Cases/yr	0.7	1.5	3	4.8	13	3.7
Single employer/stable ownership (1995–2004)						
Rate (95% CI)	3.4 (3.0–3.8)	3.9 (3.7–4.1)	3.9 (3.8–4.0)	3.4 (3.3–3.5)	3.2 (3.1–3.3)	3.5 (3.5–3.6)
N, employers	51.9	159.0	171.1	131.4	37.3	550.7
Total cases	272	2,237	5,030	6143	3942	17,624
Multiple employer/changing ownership (1995–2004)						
Rate (95% CI)	13.2 (11–16)	5.3 (4.7–5.9)	4.7 (4.4–5.0)	3.7 (3.5–3.9)	3.6 (3.5–3.7)	3.9 (3.8–4.0)
N, employers	4.6	14.3	25.4	28.1	18.5	90.9
Total cases	103	277	929	1505	3286	6100

[a]Excludes temp agencies; N, average size, and total workforce based on observation time average over 1995–2004; cases and P-yrs classified on size at time of observation.
[b]Back injuries defined as ICD-9: 721.20–721.49, 722.10–722.29, 722.50–722.59, 722.72–722.73, 722.92–722.93, 724.00–724.99, 846.00–846.99, 847.10–847.49, 847.90–847.99.
[c]In equivalent 10-year employers; actual number of employers was larger due to less than 10 years presence.

subject to uncertainty over number of employees (see footnote 2). However, similar trends were observed using data on actual staffing levels.

Interventions

The proportions of employers making use of BWC interventions generally increased with workforce size (Table II). Consulting on ergonomics was provided to 62% of the largest NH employers compared with 11% among the smallest employers. The number of consulting hours utilized over the 10-year period also increased with workforce size from 7.9 (SD = 6.7) to 38.2 (SD = 45.9) hr, possibly reflecting participation at multiple locations for larger employers. Hours of ergonomics courses conducted showed less systematic dependence on employer size, with mid-size employers receiving the most hours (mean = 9.8, SD = 8.5) (Table II). The proportions of employers receiving equipment grants increased with size (from 1% to 21%) but the expenditure per employee decreased with size, owing to the $50,000 cap on expenditures shared with BWC.

Whether or not a NH used an intervention during 2000–2004 was predicted from injury rates prior to July 1999. Comparing NHs with a prior annual rate of 6 versus 3 per hundred, the odds of using an intervention increased by factors of 1.38 for grants, 1.55–1.66 for consulting, 1.53 for courses in ergonomics, and 1.86 for other courses ($P < 0.0001$; data not shown). Employers often used more than one intervention and these utilizations were correlated. Most strikingly, 96% of recipients of grants also received consulting in ergonomics (a part of the grants program) versus 31% among non-recipients. Grant recipients generally received other interventions at 2–3 times the rate of other NHs. Video use, sometimes a substitute for other means of prevention, was positively but weakly correlated with equipment purchases.

Back injury costs

During 10 years of observation, the 23,724 back injuries in 887 NH generated $232 million in BWC payments (Table III), including medical bills ($80.6M), lost-time indemnity ($60.2M) and reserves set aside for future payments ($91.4M). The average total cost per case was $9,790 and the average annual cost per worker was $355 (=$232M/654,292P-Yrs). Costs were positively skewed, with mean costs greater than the 75%ile for many of the cost distributions. Mean total costs per worker employed per year, averaged across NHs, consistently declined with increasing workforce size, from $522 to $338.

TABLE II. Nursing Home Employers: Cumulative BWC-Sponsored Interventions 1995–2004 by Size of Estimated BWC-Covered Workforce, 1995–2004 in Ohio

Workforce size	10–20	21–50	51–100	101–200	201+	All
Consulting						
Ergonomics % of employers using	11.2	29.2	43.6	53.9	61.8	37.9
Mean hours in users (SD)	7.9 (6.7)	16.1 (28)	21.1 (28)	24.7 (36)	38.2 (46)	22.6 (33)
IH % of employers using	1.3	5.8	9.7	15.4	13.2	8.7
Mean hours in users (SD)	1.9 (1.9)	12.8 (32)	12.6 (26)	8.9 (12)	6.8 (10)	10.3 (21)
Safety % of employers using	10.5	27.0	31.3	39.0	54.4	30.0
Mean hours in users (SD)	13.5 (22)	15.2 (20)	15.1 (19)	15.6 (23)	18.6 (21)	15.7 (20)
Courses						
Ergonomics % of employers using	6.6	11.5	12.4	20.3	29.4	14.1
Mean hours in users (SD)	6.1 (2.6)	6.3 (3.0)	9.8 (8.5)	7.4 (3.9)	7.3 (5.4)	7.7 (5.5)
Other % of employers using	18.4	38.1	43.2	64.3	64.7	43.6
Mean hours in users (SD)	18.5 (20)	19.8 (22)	27.7 (35)	23.3 (22)	32.7 (34)	24.5 (28)
Video loans						
% of employers using	1.3	7.1	10.4	16.5	13.2	9.5
Mean tapes loaned (SD)	3.0 (2.8)	3.5 (2.2)	2.4 (2.1)	3.5 (4.0)	2.9 (1.6)	3.1 (2.9)
Equipment purchases						
% of employers using	0.7	6.6	16.2	12.1	20.6	10.6
Mean $/employee, users (SD)	1999 (—)	882 (468)	597 (246)	322 (152)	162 (79)	528 (376)
Any BWC-sponsored intervention						
% of employers using	29.6	51.3	67.2	79.1	76.5	59.9

Excludes temp agencies; N, average size, and total workforce based on time average over 1995–2004.

TABLE III. Back Claim Costs—All Nursing Homes (887 Total NHs, Average of 642 in Each 6-Month Period) by Size of Estimated Workforce, 1995–2004

Workforce size	<21	21–50	51–100	101–200	201+	All
Costs[a]						
Total medical, $1,000s	1,475	9,286	19,813	27,276	22,745	80.6 M
Total indemnity, $1,000s	1,079	6,920	14,523	19,581	18,142	60.2 M
Total MIRA reserve, $1,000s	1,407	9,890	22,129	30,500	27,490	91.4 M
Total combined, $1,000s	3,961	26,096	56,465	77,357	68,376	232.5 M
Medical, per case, $ mean (Q3)[b]	3,935 (3,086)	3,694 (2149)	3,325 (1,977)	3,566 (2,081)	3,147 (1,709)	3,397 (1,963)
Indemnity, per case, $ mean (Q3)	2,878 (438)	2,753 (686)	2437 (420)	2,560 (500)	2,510 (357)	2,539 (467)
MIRA reserve, per case, $ mean (Q3)	3,751 (0)	3,934 (0)	3714 (0)	3,988 (0)	3803 (0)	3,853 (0)
Total, per case, $ mean (Q3)	10,563 (4,739)	10,380 (3,368)	9,476 (3,244)	10,115 (3,531)	9,460 (2,975)	9,790 (3,291)
Medical, per P-Yr, $ mean (Q3)[c]	208 (90)	172 (172)	148 (162)	121 (155)	114 (137)	155 (153)
Indemnity, per P-yr, $ mean (Q3)	155 (8.3)	132 (116)	109 (123)	92 (120)	89 (124)	117 (110)
MIRA reserve, per P-Yr, $ mean (Q3)	159 (0)	206 (67)	162 (177)	150 (177)	135 (172)	169 (138)
Total, per P-Yr, $ mean (Q3)[d]	522 (108)	510 (451)	419 (508)	364 (443)	338 (430)	441 (430)
Aggregate total costs per P-Yr	451	417	378	351	321	355

[a]Excludes temp agencies. Nominal costs as reported by BWC in February 2005.
[b]75th %ile (Q3) over all claims in size stratum.
[c]75th %ile (Q3) over all NH with observation time in size stratum.
[d]Mean across employers of employers' average total costs per claim.

Descriptive Findings on Nursing Homes With Staffing and Resident Acuity Data

Based primarily on facility name and address, 379 out of 887 NH BWC employers were linked with OSCAR facility information at five points in time. Based on direct resident-care staff size (OSCAR data), time trends in claim rates were similar to the previous analysis based on BWC data alone, although there was a smaller rate of increase in the smallest size category. Rates and costs per person based on resident-care staff size were higher than those based on employer size because the resident-care staff (where most back injuries were assumed to occur) is a subset of the employer's workforce. For the 379 linked NHs, the mean resident-to-staff ratio (RSR) was 1.57 and decreased as NH staff size increased (Table IV). This ratio is across all work shifts. At any point in time, the ratio of residents to the workers present would be 2–3 times higher. Hazard exposure measures (products of RSR and an acuity measure) also decreased with NH size.

Regression Models of Back Injury Rates

Models based on BWC claim data only

In the Poisson regression model with all NH employers (n = 887) (Table V), injury rates decreased about 0.6% per year [RR = 0.994 = exp(−0.003 × 2)]and decreased by more than a factor of 2.0 with increasing NH size. In a modified model with terms allowing for size-specific time trends (e.g., interaction with size), time trends did not differ significantly by size (data not shown). No significant effects in the individual consulting categories were found but in another alternative model that substituted a term for total consulting hours (all categories) there was a 1% reduction in back injury for 10 hr consulting (data not shown). A protective effect for receiving up to the median course hours (over 1995–2004) in ergonomics training was highly significant (RR = 0.81, 95% CI = 0.70–0.93), corresponding to a 19% reduction. However, if training hours exceeded the median used (typically two or more 1-day courses) the courses appeared to offer no protection (RR = 0.81 × 1.34 = 1.08). For non-ergonomic training courses, a similar but smaller scale and statistically non-significant pattern was observed. Having any prior BWC grant for equipment purchases (indicator = 1) was associated with higher injury rates (RR = 1.34) while the amount per worker in grant expenditure was associated with a highly significant reduction in injury rates (RR = 0.59, 95% CI = 0.41–0.84, or a 41% reduction below the elevated baseline for users). The net effect associated with a prior expenditure of $500 per worker was a 21% reduction in back injuries (1–RR; RR = exp (0.296–0.0238 $(500)^{0.5}$) = 0.789; χ^2 (2 df, adjusted for over-dispersion) = 11.6, $P = 0.003$). The positive utilization indicator estimate could reflect an association between the utilization decision and prior injury rate, but could also be due to increased reporting of injuries with ergonomic programs that include equipment purchases (training in injury reporting was part of the grants program [Fujishiro et al., 2005]), or possibly due to model misspecification

TABLE IV. Back Injury Rates (Per 100 Workers Per Year), Staffing, Resident Acuity and Back Claim Costs (379 Nursing Home Facilities, Based on Linked Workers' Compensation and OSCAR Data) by Size of Estimated Resident-Care Workforce, 1995–2004

Staffing size	**<51**	**51–100**	**>100**	**All**
Rate/100	7.5	6.6	5.9	6.7
N, employers[a]	142	115	35	234
Average size	34.6	68.3	126.1	73.3
Total workforce (%)	4,913 (28.6)	7,882 (46.0)	4,354 (25.4)	17,148 (100)
Total cases	3,664	5,204	2,568	11,436
Total P-Yrs	49,128	78,820	43,538	171,486
Resident-to-staff ratio (SD)	1.79 (0.74)	1.54 (0.26)	1.37 (0.23)	1.57 (0.58)
Mean resident acuity[b]				
ADL index hazard (SD)	17.84 (7.3)	16.05 (2.9)	14.37 (2.3)	16.14 (5.7)
ACU index hazard (SD)	18.14 (7.4)	16.39 (2.9)	14.76 (2.3)	16.48 (5.7)
ADL Score hazard (SD)	7.14 (3.2)	6.33 (1.3)	5.48 (0.97)	6.34 (2.5)
PROPAC hazard (SD)	197.07 (100)	178.21 (37)	157.95 (29)	178.47 (76)
Mean costs[c]				
Medical, per case, $ mean (Q3)[d]	3,513 (2070)	3,432 (2,084)	3,588 (1,927)	3,493 (2,043)
Indemnity, per case, $ mean (Q3)	2,532 (452)	24,58 (203)	2,807 (1,023)	2,560 (500)
MIRA reserve, per case, $ mean (Q3)	3,983 (0)	4,084 (0)	3,842 (0)	3,997 (0)
Total, per case, $ mean (Q3)	10,027 (3,404)	9,974 (3,467)	10,238 (3,713)	10,050 (3,506)
Medical, per P-Yr, $ mean (Q3)[e]	249 (278)	167 (265)	143 (223)	202 (260)
Indemnity, per P-yr, $ mean (Q3)	190 (199)	119 (185)	105 (169)	151 (193)
MIRA reserve, per P-Yr, $ mean (Q3)	294 (239)	216 (306)	155 (223)	244 (279)
Total, per P-Yr, $ mean (Q3)[f]	734 (731)	503 (787)	403 (633)	598 (736)
Aggregate total cost, per P-Yr	748	659	604	670

[a]In equivalent 10-year employers; actual number of employers was larger due to less than 10 years presence.
[b]Product of mean acuity measure and resident-to-staff ratio for each facility; SD estimated from NH status when last observed.
[c]Nominal costs as reported by BWC in February 2005.
[d]75th %ile (Q3) over all claims in size stratum.
[e]75th %ile (Q3) averaged over all NH with observation time in size stratum.
[f]Mean across employers of employers' average total costs per claim.

TABLE V. Impact of BWC-Sponsored Interventions on Back Injury Rates, BWC Data Only (887 NHs and Subgroups) by Poisson Regression Model Using Data for 1995–2004

	Estimate	**RR**	**95% CI[a]**	**Reference for estimate and RR**
Size: <21 (intercept)	−2.527	1.0		Reference
Size: 21–50	−0.368	0.69		
Size: 51–100	−0.576	0.56		
Size: 101–200	−0.790	0.45		
Size: 201+	−0.972	0.38		
Time trend, per 6 months	−0.003	0.99	—	Est: per 6 months/RR: per year
Courses[b]				
(ergo > 0.0)	−0.214	0.81	0.70–0.93	ergo = 0
(ergo > med)	0.289	1.34	1.11–1.60	ergo = 0
Indicator: equip. purchase (0,1)[c]	0.296	1.34	0.99–1.82	Equip. purchase = 0
Equip. purchase, $ (sqrt)[c,d]	−0.024	0.59	0.41–0.84	RR: $500 vs. 0

[a]95% confidence interval, adjusted for over-dispersion in Poisson model.
[b]Courses: time-dependent indicators of whether use was greater than 0.0 hr or greater than median use of users; model also included courses (other), and consulting measured in same way as courses (ergo).
[c]Chi-sq (2df), adjusted for over-dispersion, for indicator and purchase amount: 11.6, $p = .003$.
[d]Equipment purchases: square root of dollars per worker.

TABLE VI. Impact of BWC-Sponsored Interventions on Back Injury Rates, BWC Data and OSCAR Data on Resident-to-Staff Ratios and Resident Acuity Scores (Subgroup of 379 NHs Only) by Poisson Regression Model Using Data for 1995–2004

	Estimate	RR	95% CI[a]	Reference for estimate and RR
Size: <21 (intercept)	−2.54	1.00		Reference
Size: 21–50	−0.195			
Size: 51–100	−0.393			
Size: 101–200	−0.385			
Size: 201+	−2.20			
Time trend, per 6 months	0.0045	1.01		Est: per 6 months/RR: per year
Resident-to-staff ratio[b]	0.280	1.32	1.18–1.48	RSR <= 1.0
ADL Score hazard measure[c]	0.345	1.09	1.01–1.18	75th %ile vs. 25th %ile
PRO hazard measure[c]	−0.139	0.96	0.91–1.01	75th %ile vs. 25th %ile
Courses[d]				
(ergo > 0.0)	−0.154	0.86	0.69–1.07	ergo = 0
(ergo > med)	0.210	1.23	0.96–1.58	ergo = 0
Video tapes borrowed[e]	0.036	1.43	0.94–2.18	Per 10 tapes
Indicator: equip. purchase (0,1)[g]	−0.072	0.93	0.69–1.25	Equip. purchase = 0
Equipment purchases (sqrt)[f,g]	−0.0054	0.85	0.52–1.40	RR: $908 vs. 0[h]

[a]95% confidence interval, adjusted for over-dispersion in Poisson model.
[b]Presented as: max (0,RSR − 1).
[c]Hazard measures based on product of resident/staff ratio and source acuity measure. ADL: (ln(ADL Score × RSR + 1)). PRO: (ln(PROPAC × RSR + 1)).
[d]Courses: time-dependent indicators of whether use was greater than 0.0 hr or greater than median use of users; model also included courses (other) and consulting measured in same way as courses (ergo).
[e]Videos: no. of tapes borrowed divided by 10.
[f]Equipment purchases: square root of dollars per worker.
[g]χ^2 (2 df), adjusted for over-dispersion, for indicator and purchase amount: 7.14, $P = 0.028$.
[h]$908/resident care worker is equivalent to $500/worker based on the payroll.

(see Discussion Section). When expenditure was specified using separate terms for each employer size category, the protective effect was greatest for the largest employers compared to the others; with increasing size, RR = 0.74, 0.84, 0.80, 0.82, and 0.64, respectively (data not shown) but the differences were not significant ($P = 0.6$).

Models based on BWC-OSCAR linked data

For the 379 NHs with facility-specific data, the size dependence of back injury was similar to that of all NHs (with size ranges now applied to the resident-care population). The resident-to-staff ratio was entered in the model as RSX = max(0,RSR − 1), so that the reference was RSR equal to or less than 1.0 (the 3.5%ile for RSR). The RSR coefficient implied that the back injury rate increased by 32% (RR = 1.32, 95% CI = 1.18–1.48) (Table VI) for each additional resident per staff member (from all shifts combined). Because RSR was used in creating the acuity hazard terms, themselves risk factors (see below), the overall impact of an additional resident per worker was higher at 1.50 (computed at average acuity levels). Thus, for an RSR of 2.0 residents per staff (approximately 85%ile), the injury rate was 50% above the reference level (RSR = 1.0). The four acuity measures were highly correlated (correlations ranging 0.89–0.99); two of them (log-transformed, e.g., ln[ADL + 1]) were included in the final model: ADL Score (RR = 1.09, 95% CI = 1.01–1.18 comparing 75th %ile vs. 25th %ile on ADL Score), and PROPAC (RR = 0.96, 95% CI = 0.91–1.01 comparing 75th %ile vs. 25th %ile on PROPAC), the latter being a protective effect, apparently moderating the ADL Score and RSR effects.

The combined effect of the grant indicator and expenditure terms for equipment was a total injury rate reduction of 21% when expenditure was ($908/resident care worker) (0.93 × 0.85 = 0.79; statistically significant; χ^2 (2 df, adjusted for over-dispersion) = 7.14, $P = 0.028$) (Table VI). $908/resident care worker is equivalent to $500/worker based on the payroll estimates for total staff used in the other model.[3] When the RSR was greater than 2.0, there was a total reduction of 45% in back injuries for $908 per worker in prior expenditure (RR = 0.55, $P = 0.12$) (data not shown).

[3] Total person-years in group of 379 NHs based on payroll estimates: 311,257. Total-person years based on OSCAR resident care staffing data: 171,486. $500(311,257/171,486)=$908.

Alternate models

The possibility that some intervention effects might be more accurately modeled by assuming that they diminish over time was examined by reducing the measures of past intervention by a fixed proportion for each subsequent month of observation, corresponding to some specified ''half-life.'' However, these attempts did not improve model fit. For example, applying a 1-year half-life to interventions resulted in estimates of less significance for the protective effects of courses on ergonomics. For consulting on ergonomics, a slightly stronger effect was observed (for more than 9.8 hr consulting, the population median) with a 1-year half-life (RR = 0.88) but it was not statistically significant. The effects of equipment expenditures were still statistically significant but greatly diminished.

The models presented here assumed the same effect regardless of size for consulting and courses—but alternate approaches were tested. When management consultation and training hours were re-scaled to hours per worker, the statistical significance of protective effects of training courses in ergonomics was reduced; the non-significant positive estimate (non-protective) for above-median use of other training courses was substantially increased, suggesting possible intervention selection for higher prior risk (data not shown).

Other Musculoskeletal Disorders (MSDs)

In addition to 23,724 back injuries during 1995–2004 among all Ohio NHs with BWC insurance, there were 7,536 compensated injuries to the shoulder that did not also involve injury to the back, and 3,308, 1,424, and 283 injuries respectively, to the knee, elbow and neck. These other musculoskeletal injuries contributed $77M in total claim costs in addition to the $232M in back claim costs (Table VII). The same model as described above (Table V) was estimated using data for all 887 NHs, but replacing the dependent variable with the claim rate for all MSDs or for other specific body sites. Non-significant impacts were observed for other specific body sites, but equipment purchases ($500) were significantly associated with the overall MSD rate (RR = 0.86, $P = 0.03$) (Table VII).

Cost Implications of Model Results

Reductions in injury costs might logically come from two sources, a reduced rate of claims and reduced average cost per claim, but, based on separate regression analyses, prior interventions had small, varying, and statistically insignificant impacts on cost per claim. A prior $500 equipment investment per worker in the group of all 887 employers was associated with a claim rate reduction of 21%. Since the average annual cost of claims per worker was $365 in 2001 dollars,[4] the estimated annual cost reduction for back injuries is $77 (=0.21 × $365) per worker (Table V). Because 10 years is a plausible estimate of the useful lifetime for mechanical resident lifting equipment that is often used in health care cost estimation, total savings per worker would be about $766, or a net saving of $266. But because cost savings would not be realized immediately, total savings should be discounted.[5] Using a 5% discount rate,[6] the total savings in terms of real present value would be about $495, yielding a small net cost of $5 per worker, or 50 cents per worker per year.[7] Because we observed diminishing returns to equipment purchases, greater expenditures would be associated with a more substantial net cost, and lesser expenditures would be associated with net savings. Amortization of equipment over less than 10 years would also reduce the net benefit realized.

For all MSDs combined, the model implied that a $500 investment per worker lowered the MSD injury rate by 14% (RR = 0.86) (Table VII) Since the average annual cost of MSD claims per worker was $499, the annual claim cost reduction was $70 (=0.14 × $499) or $698 over 10 years. Discounted at 5%, the savings would be $451 for a net cost of $49 per worker or about $5 per worker per year.

For nursing homes with OSCAR data, the estimated percent reduction in back injury claims for a $908 investment per resident care worker (equivalent to a $500 investment per worker in the model for all NHs) was the same as in the other model (21%) so the estimated net cost per worker is the same as well. However, for nursing homes with OSCAR data and resident-to-staff ratios greater than 2.0, the saving in back claim costs from a $908 investment per resident care worker was $1,643 or, discounted at 5%, $1,062 for a net saving of $562 ($1,062–$500) per worker or $56 per worker per year (Tables IV and VI)[8].

4 Average of annual estimates of the average claim cost per worker, 2000–2004. Proportion of total reported costs stated in dollars of different years was inferred by increase in percentage of total costs paid with each year of increase in age of claims. Conversion to 2001 dollars using GDP price indexes [USDCBEA, 2008].

5 The distribution of claim costs over the years following injury were estimated using the increase in percentage of total costs paid with each year of increase in age of claims. Savings in the first year following initial investment were discounted over a period of one half year; savings in the second year were discounted over 1.5 years, etc. This reflects the average lag time between investment and prevented claims.

6 A 3% discount rate is a standard for public health investments [Corso and Haddix, 2003] and 7% (the approximate long run average, inflation-adjusted return in the stock market) is the standard of the Office of Management and Budget (OMB) for most government investments [OMB, 1992]. We see investment in reducing injury rates as an investment in public health, but it is also a means of reducing employer costs, and it should also be noted that employers paid 20% or more of the equipment cost. The latter perspective would suggest a higher discount rate that is somewhat closer to the private rate of return on investment. (See footnotes for results based on alternative discount rates.)

7 Total savings resulting from a $500 investment per worker were $583 discounted at 3%, $426 discounted at 7%, and $348 discounted at 10%.

8 Total nominal savings = (0.45×$365) × 10 years = $1,643. Total savings from a $908 investment per resident care worker were $1,250 discounted at 3%, $914 discounted at 7%, and $747 discounted at 10%.

TABLE VII. Back and Other Musculoskeletal Injuries: Claims, Costs, and Impact of Equipment Purchases on Claim Rates, BWC Data Only (All 887 Ohio Nursing Homes) 1995–2004

Injury site	All MSDs[a]	Back	Shoulder[b]	Knee[c]	Elbow[d]	Neck[e]	Total[f]
Cases[g]	33,690	23,724	7425	3,255	1,398	279	36,081
Cases, mutually exclusive[h]	33,690	23,724	5,999	2,822	1,085	64	33,694
Rate/100	5.1	3.6	0.92	0.43	0.17	0.01	5.2
95% CI	5.09–5.20	3.58–3.67	0.90–0.94	0.42–0.45	0.16–0.18	0.008–0.012	5.19–5.30
Total cost, $1000s	309,512	232,255	48,843	22,541	4,048	1,945	309,633
Cost per case, $	9,187	9,790	8,142	7,988	3,731	30,395	9,190
Cost per person-Yr, $	472	355	74.8	34.5	6.2	3.0	473
RR[i] at $500	0.86	0.79	1.08	0.91	1.28	0.70	—

[a]All musculoskeletal disorders (MSDs): based on model where cases include any back, shoulder, knee, elbow, or neck injury.
[b]Shoulder cases defined: ICD-9 (726.00–726.29, 840.00–840.99).
[c]Knee cases defined: ICD-9 (726.60–726.69, 844.00–844.39, 844.80–844.99).
[d]Elbow cases defined: ICD-9 (726.30–726.39, 841.00–841.99).
[e]Neck cases defined: ICD-9 (722.40–722.49, 722.71, 722.91, 723.00–723.99).
[f]Discrepancy between All MSDs and Total probably due to duplicate claims with non-identical ICD coding.
[g]All actual nursing home employers
[h]Outcomes mutually exclusive, selected in order: back > shoulder > knee > elbow > neck (i.e., "knee" implies not back or shoulder injury but may include elbow or neck).
[i]RR - relative rate from model with term for indicator of equipment purchase and term for square-root of purchase amount.

Although there are reasons to question why only NHs whose managers received a relatively small number of course hours (up to the median) experienced a 19% reduction in claims (Table V), it is useful to compare the associated claim cost savings with the investment in courses. A 19% reduction in claim rate translates to an annual savings of about $69 per worker ($0.19 \times \$365$) which, for an average sized NH of 102 employees, amounts to $7,074 annual savings. According to the model these savings, extending over 3 years, would total about $21,221. Discounted at 10% (a more appropriate rate since investment in courses is mainly private rather than public) the present value of the cost saving would be $18,451. Most NHs sent one student and most of the rest sent two students for a 1-day course. We estimate the time managers spent taking courses would have been worth about $400 per NH, and that these students' share of the cost of instruction would have been in the range of $50–$100.[9] Thus the estimated course costs (<$500) are a small fraction of estimated claim cost savings.

The calculations above focus narrowly on claim cost savings and a portion of the intervention cost. A complete accounting of costs and benefits would include additional intervention costs such as equipment maintenance, any net increase in employee time spent lifting residents, and managerial time spent implementing lifting policies. Additional cost savings would accrue from reduced, injury-related schedule disruptions and reduced loss and replacement of injured employees. Reduced injuries may also improve work productivity and quality and continuity of care for residents. It is also well known that many, generally less severe injuries do not result in workers' compensation claims. Reduction in unreported injuries would also reduce costs. Also important are reduced loss of earnings for workers (far from fully compensated) and avoided reduction in quality of life due to injury.

9 Based on average students per NH of 1.3, estimated 7.4 hr per student and an estimated $40/hr compensation of NH managers, value of time per NH $= 1.3 \times 7.4 \times 40 = \$384$. Cost of instruction based on assumption of $1,000 instructor cost for 1-day course, class size of 20 and 1.3 average students per NH.

DISCUSSION

Each of the two models used to estimate the relationship between interventions and claim rates has advantages. One model is based on data for a much larger group of 887 NHs that includes many more of the larger, and all of the multi-facility employers. The other is based on data for 379 NHs that has more accurate staffing figures as well as variables for resident/staff ratio and resident acuity. Although the association of equipment expenditure with back injury rate decline was about the same in these models, there is some evidence that the estimated impact of expenditures would have been higher if better data had been available for all NHs. In a variant of the first model, the largest NH size category showed the steepest claim rate declines with expenditure. Also, when this model was estimated separately for those generally larger NHs that were not included in the second model (results not shown) the impact of equipment purchases was found to be almost 27% greater than for all 887 NHs.

The possibly larger impacts of equipment expenditures for larger NHs suggest the possibility of greater cost savings for larger NHs as well. At the same time, the smaller NHs generally have higher claims costs per employee (due mostly to higher claim rates; see Table III) and thus, some of them may also have experienced greater cost savings than are suggested by the overall results. Another likely reason for variation in impact of equipment purchases is variation in types of equipment purchased. Although the great majority of grants were used, at least in part, to reduce lifting [Fujishiro et al., 2005], no information was available on the specific equipment purchased by NHs and so no impact estimates for specific equipment types was possible. While greater cost savings might have been expected when considering all musculoskeletal claims versus back claims only, we estimated slightly lower cost savings (but not significantly different than the cost savings with respect to back claims) due to the fact that we did not observe significant impacts for other claim injuries to other parts of the body.

Resident-to-staff ratio was a clear risk factor for musculoskeletal injury and appeared to have slightly greater effect with higher resident impairment level or acuity. This supports a previous finding of an association of worker injury with staff levels [Trinkoff et al., 2005]. The importance of these findings is underlined by a comprehensive report to the U.S. Congress in 2002 that found inadequate staffing levels in most nursing homes [CMS, 2002], and an Institute of Medicine report that examined the impact of staffing levels on quality of care [IOM, 2004]. In addition, low staffing results in time pressures, which have been observed anecdotally to impinge on NH safety. In a NIOSH focus group assembled for this study (Convergys, Market Research Services, December, 2002), nursing home managers readily agreed that if their employees followed the work practices recommended for injury avoidance, they would be unable to complete their assigned work in the allotted times. Other observers (including nursing home workers in another NIOSH focus group, December, 2002) have reported that equipment for assisting in resident transfers sometimes goes unused because the work can be accomplished faster without it.

Several patterns in the data suggest that organizational factors are important influences on injury rates. First, lower injury rates were observed for larger employers. Second, the protective effect of equipment purchases was enhanced in larger employers. Third, rates were higher in enterprises with complicated ownership history (acquisitions, mergers, changes in ownership and lapses in operation). This suggests a hypothesis that resident lifting teams or procedures designed to reduce injury risks may be more feasible or likely to be used in larger organizations, and that it may be useful to consider organizational factors in targeting interventions.

Obstacles to Interpretation

The most critical limitation was that management decisions to participate may have depended on important but unknown factors that are themselves determinants of injury risk. Nursing homes receiving services and grants may have been more motivated to improve safety than those that did not, and BWC stated that it sought well motivated, high injury rate NHs, in delivering services. We found evidence that employers using BWC-sponsored interventions had higher prior injury rates than non-users. NHs with (temporarily) high injury rates may also have tended to see subsequent declines due to ''regression to the mean.''

Modeling injury rates using stratification on employer was a defense against selection bias associated with unknown NH-level risk factors that are constant over time. In the case of equipment purchases, the coefficient for the indicator of prior purchase might also have captured mainly a selection effect, specific to the period following equipment. However, we chose to include its influence on injury as a portion of the overall, preferred estimate of equipment impact. The observed indicator coefficient was positive in the model applied to all 887 NHs, rather than negative as we might have expected. This increased the probability that it represents something other than a selection effect. First, NHs pursuing grants may have increased employee awareness and reporting of work-related injuries. Second, it is possible that model misspecification played a role. If the intervention response has a sub-linear form but is not modeled well with a square-root transformation, an upward bias of the intercept for utilizers and overestimation of the decrease in rate with expenditure amount could result. In a robustness check on model specification, we varied the power of the purchase amount variable from 0.25 to 1 and observed that this had substantial impacts on the coefficients of both the indicator and purchase amount, but little effect on the combined effect of them together. The latter thus represents a more stable estimate. It is also a more conservative choice for the model that includes all NHs, because it is substantially lower than an estimate based only on the equipment amount coefficient.

The small and equivocal protective effects of consulting may have been due to the fact that BWC consulting recipients were compared to NHs that often had consulting from other sources. In a supplement to the Annual Survey of Long-term Care Facilities administered in early 2002 by the Ohio Department of Aging (43% response rate), 55% of respondents made use of safety and health consultants in the previous 3 years, and 47% did so in the previous year [Mehdizadeh, 2003] but consulting was not provided exclusively by BWC. In the previous 3 years, 31% had received consulting from BWC, 12% from OSHA, and 23% from other sources (some received consulting from more than one source).

More valid estimates of the effectiveness of BWC interventions would require additional data and the implementation of interventions in a way that would provide valid comparison groups and reduce the self-selection bias problem. Needed additional data include (1) disaggregated, facility-specific data on interventions and injuries, (2) number of employees and FTE estimates for reporting periods by manual classification, and (3) an annual summary of interventions (consultation, training) received or undertaken by NHs independently of BWC. Comparison groups could be created by focusing interventions on certain groups of NHs or delivering them to different groups at different times.

Current Findings and Other Studies

Nursing home worker injuries have been the focus of many studies, including those a part of the 1995 NIOSH research agenda [Collins and Owen, 1996]. Several studies addressed impacts of some of the same factors upon NH injury rates, some of them using similar data.

Fujishiro et al. [2005] studied ergonomics interventions (consulting and equipment purchases) sponsored by BWC in Ohio during 1999–2003 in 86 primarily nursing home facilities, compiling a detailed inventory of the types of equipment purchased for addressing bending, lifting, and carrying. The median rate of MSD injuries was reduced by half with the sponsored interventions, particularly those focused on carrying. However, these results were for the specific work units in which equipment was installed, not the entire facility workforces. The present study included most or all of the facilities studied by Fujishiro et al. over a longer period–1995–2004. The number of employers comprising the 86 facilities was not reported by Fujishiro et al.; in the present study, the number of ‘‘ultimate’’ employers with BWC equipment assistance was 94. Claim costs and risk factors such as facility size, resident acuity or staffing levels were not examined in the Fujishiro et al. study.

The Veterans Health Administration (VHA) evaluated ceiling-mounted resident lifts on a 60-bed nursing home unit deemed to be ‘‘high risk’’ based on injuries reported over a 2-year period [Tiesman et al., 2003]. At 12 months post-intervention, the incidence of injuries was just slightly lower; however, there were no lost workdays versus 39 in the 12 months before intervention and caregivers indicated a high level of satisfaction with the program. In a separate VHA study [Nelson et al., 2003], a program including mechanical resident lifts, resident care assessment protocols, no-lift policies, and training on resident handling equipment was evaluated in 23 high-risk long-term care units in seven facilities with 780 nursing personnel. Post-intervention, there was a significant decrease in injuries and modified duty days, an increase in caregiver satisfaction, and a decrease in ‘‘unsafe’’ resident handling practices. Ninety-six percent of the nurses ranked lifting equipment as the most important program element.

In a NIOSH study, Collins et al. [2004] observed that a resident-handling and movement program, including the introduction of mechanical lift devices, reduced worker compensation injury rates by 61%, lost workday injury rates by 66%, and restricted workdays by 38%, and the number of repeat injuries was reduced. During the 36 months before the intervention there were 129 workers’ compensation claims attributed to resident handling, and 11 workers with more than one claim. During the 36-month post-intervention period, 56 workers’ compensation claims were attributed to resident handling and only 3 employees filed more than one claim.

Trinkoff et al. [2005] analyzed workers’ compensation first-reports-of-injury linked with OSCAR facility data from three states, including Ohio, for the year 2000. Injury rates were calculated with facility staffing data for resident-care employees which included RNs and contract workers. (In the present study, RNs were not included and contract workers were included in the resident-to-staff ratio calculation but not in the population at risk.) Trinkoff et al. were able to link BWC and OSCAR data for 323 Ohio facilities, comparable to the number of facilities whose data was linked in the present study (379). Trinkoff et al. observed a reduction in injury rates with (a) increasing facility size (as observed in the present study), and (b) hours of staff time available per resident (as observed here with the roughly comparable measure: resident-to-staff ratio). The effect of training for nursing aides (approved training programs) was protective but not significant, and there was no dependence of injury rate on the ACU resident acuity index, whereas in the present study the ADL score was a significant predictor of worker back injury.

In 1996, Myers et al. [2002] examined back and shoulder injury rates in a 160-bed facility in the State of Washington for 18 months using workers’ compensation claims linked with resident characteristics data. They found small non-significant injury risk associated with cumulative exposure to resident-related risk factors, the most prominent being lack of voluntary leg mobility (OR = 1.15, 95% CI 0.97–1.27). However, cumulative measures may not have been the best exposure metrics for these outcomes, in part due to survivor effects. An association of claims with staff turnover led these authors to conclude that social and work organizational issues were probably more important than resident attributes in predicting injury. The present study constructed risk factors based on current rather than cumulative work hazards and, being state-wide and population-based, had much larger numbers of injuries available for analysis (23,724 vs. 41).

CONCLUSIONS

In Ohio nursing homes during 1995–2004, expenditures for equipment to reduce physical stress in handling residents were associated with substantial claim cost reductions that were similar in magnitude to the initial public investment on a present value basis. A number of additional, but important cost savings and benefits, as well as some of the costs of new equipment could not be estimated. Training courses in ergonomics, whose costs were principally borne by employers, were associated with relatively modest and inconsistent claims reductions, although the ratio of cost saving to course costs appeared great. Consulting impacts independent of equipment purchases were small, equivocal and non-significant, although data gaps were serious enough to make a strong negative conclusion unwarranted. Injury rates were also observed to depend on staffing ratios and to be more modestly associated with nursing home resident impairment levels.

ACKNOWLEDGMENTS

This work depended on assistance from numerous individuals at the Ohio Bureau of Workers' Compensation, including: James Fograscher, Joy Bush, Dave Bush, James Schutte, Roman Wilshanetsky, Bill Darlage, John Papadopoulis, Teresa Arms, David Robins, Christopher Hamrick, Roger Aber, Michael Donohue and others, and on contributions from Dr. Shahla Mehdizadeh and Dr. Jane K. Straker of the Scripps Gerontology Center, Miami University Oxford, Ohio. Katie Spencer assisted with file preparation and linkage at NIOSH.

REFERENCES

BWC, 2009a. Ohio Bureau of Workers Compensation. Employer services; some have changed since the time of this study: http://www.ohiobwc.com/employer/services/safetyhygiene.asp

BWC, 2009b. Ohio Bureau of Workers Compensation. Safety grants program: http://www.ohiobwc.com/employer/programs/safety/empgrants.asp

Centers for Medicare & Medicaid Services (CMS). 2002. Appropriateness of minimum staffing ratios in nursing homes. Report to Congress. Baltimore, MD. Phase I Report: http://web.archive.org/web/20020918002155/http://cms.hhs.gov/medicaid/reports/rp700hmp.asp; Phase II Report: http://web.archive.org/web/20021021095818/http://www.cms.hhs.gov/medicaid/reports/rp1201home.asp

Collins JW, Owen BD. 1996. NIOSH research initiatives to prevent back injuries to nursing assistants, aides, and orderlies in nursing homes. Am J Ind Med 29:421–424.

Collins JW, Wolf L, Bell J, Evanoff B. 2004. An evaluation of a "best practices" musculoskeletal injury prevention program in nursing homes. Inj Prev 10:206–211.

Corso PS, Haddix AC. 2003. Time effects. In: Haddix AC, Teutsch SM, Corso PS, editors. Prevention effectiveness, 2nd edition. New York: Oxford University Press. p 94–95.

Cowles CM, 2002. Nursing Home Statistical Yearbook, 2001. Cowles Research Group, Montgomery Village, MD.

Frome EL, Checkoway H. 1985. Use of Poisson regression models in estimating incidence rates and ratios. Am J Epidemiol 2:309–323.

Fujishiro K, Weaver JL, Heaney CA, Hamrick CA, Marras WS. 2005. The effect of ergonomic interventions in healthcare facilities on musculoskeletal disorders. Am J Ind Med 48:338–347.

Hosmer DW, Lemeshow S. 1989. Applied logistic regression. New York: John Wiley and Sons.

Institute of Medicine (U.S.). 2004. Committee on the Work Environment for Nurses and Patient Safety: Keeping patients safe: Transforming the work environment of nurses, Vol. xxi. Edited by: Page A. Washington, DC: National Academies Press.

McCullagh P, Nelder JA. 1983. Generalized linear models. London: Chapman and Hall.

Mehdizadeh S. 2003. Private communication. Oxford OH: Scripps Gerontology Centre, Miami Univ.

Myers D, Silverstein B, Nelson NA. 2002. Predictors of shoulder and back injuries in nursing home workers: A prospective study. Am J Ind Med 41:466–476.

Nelson A, Matz M, Chen F, Siddharthan K, Lloyd J, Fragala G. 2003. Research report: A multifaceted ergonomics program to prevent injuries associated with patient handling tasks in the Veteran's Hospital Association.

Neter J, Wasserman W. 1974. Applied linear statistical models. Homewood, IL: Richard D. Irwin, Inc.

Ohio Bureau of Workers' Compensation. 2008. Actuarial Department, email communication, March 31, 2008.

OMB (Office of Management and Budget). 1992. Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. Washington, DC: OMB Circular A-94. Available at: http://www.whitehouse.gov/omb/circulars/a094/a094.html.

Preston DL, Lubin JH, Pierce DA, McConney ME. 1993. EPICURE Users Guide. Seattle, WA: Hirosoft International Corp.

Straker JK, Applebaum R, Mehdizadeh S. 1997. Ohio nursing homes: An industry in Transition. Ohio Long-Term Care Research Project September 1997. Ohio: Scripps Gerontology Center Miami University Oxford.

Tiesman H, Nelson A, Charney W, Siddharthan K, Fragala G. 2003. Effectiveness of a ceiling-mounted patient lift system in reducing occupational injuries in long-term care. J Healthc Saf 1(1): 34–40.

Trinkoff AM, Johantgen M, Muntaner C, Le R. 2005. Staffing and worker injury in nursing homes. Am J Public Health 95:1220–1225.

US Department of Commerce. Bureau of Economic Analysis. 2008. National Income and Product Accounts. Table 1.1.4. Price Indexes for Gross Domestic Product. February 28, 2008 revision. Accessed March 25, 2008 from: www.bea.gov/dn/nipaweb/SelectTable.asp?Selected=N.

US Department of Labor. Bureau of Labor Statistics. 2008a. Survey of Occupational Injuries and Illnesses. Nonfatal Injuries and Illnesses, Case and Demographic Characteristics for Work-related Injuries and Illnesses Involving Days Away From Work, Calendar Year 2006 Survey Results, Industry X selected case characteristics, Tables R1, R2, R5, R6, R97. Accessed February 2008 from: http://stats.bls.gov/iif/oshcdnew.htm#06first.link.

US Department of Labor, Bureau of Labor Statistics. 2008b. Occupational Employment Statistics Survey. May 2006 Estimates: National Sector, 3,4, and 5-digit NAICS Industry-Specific. http://www.bls.gov/oes/current/naics4_623100.htm#b00-0000. Accessed February 2008 from: http://www.bls.gov/oes/#data.

US Department of Labor. Bureau of Labor Statistics. 2008c. Consumer Price Index. All Urban Consumers (Current Series) Series Id: CUUR0000SA0. Accessed February 2008 from: http://www.bls.gov/cpi/#data.

US Department of Labor. Bureau of Labor Statistics. 2008d. National Compensation Survey. Employer Costs for Employee Compensation, 1986–2003 (SIC Basis) (all workers, private nursing homes) Wages and salaries: Series ID CCU020000100000D, Paid leave: Series ID CCU040000100000D, Supplemental pay: Series ID CCU0-50000100000D. Accessed January 13, 2008 from webpage: http://www.bls.gov/ncs/#data.

US Department of Labor. Bureau of Labor Statistics. 2008e. Quarterly Census of Employment and Wages. Ohio and U.S., SIC 8051, private skilled nursing facilities, average annual pay, 1997–2000, Series IDs: EWU390005050I8051 and EWUUS0005050I8051; Ohio and U.S., NAICS 6231, private nursing care facilities, annual average pay, 2001–2004, series IDs: ENU390005056231 and ENUUS0005056231. Accessed January 2008 from http://www.bls.gov/cew/.

Waehrer G, Leigh JP, Miller TR. 2005. Costs of occupational injury and illness within the health services sector. Int J Health Serv 36(2):343–359.