HHS Public Access

Author manuscript

Am J Ind Med. Author manuscript; available in PMC 2015 July 16.

Published in final edited form as:

Am J Ind Med. 2014 December ; 57(12): 1398–1412. doi:10.1002/ajim.22372.

The Effectiveness of Insurer-Supported Safety and Health Engineering Controls in Reducing Workers' Compensation Claims and Costs

Steven J. Wurzelbacher, PhD[1,*], **Stephen J. Bertke, PhD**[1], **Michael P. Lampl, MS**[2], **P. Timothy Bushnell, PhD**[1], **Alysha R. Meyers, PhD**[1], **David C. Robins, AAS**[2], and **Ibraheem S. Al-Tarawneh, PhD**[2]

[1]National Institute for Occupational Safety and Health, Division of Surveillance, Hazard Evaluations, and Field Studies

[2]Ohio Bureau of Workers' Compensation, Division of Safety and Hygiene

Abstract

Background—This study evaluated the effectiveness of a program in which a workers' compensation (WC) insurer provided matching funds to insured employers to implement safety/health engineering controls.

Methods—Pre- and post-intervention WC metrics were compiled for the employees designated as affected by the interventions within 468 employers for interventions occurring from 2003 to 2009. Poisson, two-part, and linear regression models with repeated measures were used to evaluate differences in pre- and post-data, controlling for time trends independent of the interventions.

Results—For affected employees, total WC claim frequency rates (both medical-only and lost-time claims) decreased 66%, lost-time WC claim frequency rates decreased 78%, WC paid cost per employee decreased 81%, and WC geometric mean paid claim cost decreased 30% post-intervention. Reductions varied by employer size, specific industry, and intervention type.

Conclusions—The insurer-supported safety/health engineering control program was effective in reducing WC claims and costs for affected employees.

Keywords

workers' compensation; prevention effectiveness; engineering controls; ergonomics; safety

*Correspondence to: Steve Wurzelbacher, PhD, Industrywide Studies Branch Division of Surveillance, Hazard Evaluations, and Field Studies The National Institute for Occupational Safety and Health1090 Tusculum Ave, MS R-14 Cincinnati, OH 45226-1998. srw3@cdc.gov.

Disclosure Statement: The authors report no conflicts of interests.

Disclaimer: The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health or the Ohio Bureau of Workers' Compensation.

Disclaimer: This information is distributed solely for the purpose of pre dissemination peer review under applicable information quality guidelines. It has not been formally disseminated by the National Institute for Occupational Safety and Health or the Ohio Bureau of Workers' Compensation. It does not represent and should not be construed to represent any agency determination or policy.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web-site.

INTRODUCTION

In 2010, workers' compensation (WC) insurance covered over 124 million United States (US) workers at a total cost of $71 billion to employers. Total benefits paid in 2010 were $57.5 billion, including $28.1 billion in payments to medical providers, and $29.5 billion in benefits to workers [Sengupta et al., 2012]. A majority of these costs have been attributed to common ergonomic and safety-related occupational causes (overexertion, falls, struck by/against events, and repetitive motion) [Liberty Mutual, 2013]. Accordingly, occupational safety and health (OSH) research goals across many industries are to assess the effectiveness of prevention approaches for such common injury/illness causes and to emphasize evidence-based interventions.

Although, prior intervention research has been informative, employers are still seeking additional evidence to guide OSH practice. The Institute for Work and Health [Brewer et al., 2007] conducted a systematic review that found strong evidence supporting the effectiveness of secondary and tertiary prevention (to reduce the severity of injury/illness through early reporting and disability management programs), but relatively few studies supporting the effectiveness of primary prevention (to prevent injury/illness through elimination/substitution, engineering, work practice, personal protective equipment, and administrative controls). The Brewer review did not indicate that primary prevention was not effective, but emphasized that additional research on primary prevention is greatly needed.

Within primary prevention approaches, the concept of the "hierarchy of controls" states that engineering controls to reduce or eliminate OSH hazards are preferred over approaches such as work practice or administrative changes. However, relatively few studies have actually investigated the impact of engineering controls on longer term outcomes, including reported injuries/illnesses. For example, Silverstein and Clark [2004] conducted a literature review of 37 musculoskeletal disorder intervention trials from 1999 to 2003 and identified only 4 studies [Marras et al., 2000; Fredriksson et al., 2001; Shinozaki et al., 2001; Owen et al., 2002] with a focus on injury/illness outcomes associated with ergonomic engineering approaches. Rather, many prior ergonomic engineering control studies have tended to focus on short term outcomes such as workload assessments (e.g., biomechanical evaluations and exertion ratings) or musculoskeletal symptoms [van der Molen et al., 2005]. This may be due in part to the fact that large sample sizes are required to measure effectiveness with longer term outcomes (such as WC claims) that are relatively rare events.

Other researchers [van der Molen et al., 2005; Bigos et al., 2009] have suggested that primary prevention studies focused on engineering controls have been mixed in quality and findings. For example, some studies have found no effect of engineering controls on reported musculoskeletal symptoms [Tveito et al., 2004; Luijsterburg et al., 2005] or reported injuries [Fredriksson et al., 2001] post-intervention. By contrast, other researchers have found reduced injuries post-intervention [Marras et al., 2000; Shinozaki et al., 2001; Owen et al., 2002; Fujishiro et al., 2005] and reduced WC claims and costs post-intervention [Collins et al., 2004; Alamgir et al., 2008; Park et al., 2009].

Clearly there is a need to conduct further research to assess the effectiveness of engineering control-focused primary prevention approaches. The Ohio Bureau of Workers' Compensation (OHBWC) has long been interested in the evaluation of supported intervention programs to guide evidence based practices and has collaborated with several external researchers [Fujishiro et al., 2005; Park et al., 2009] to determine the cost-benefit and effectiveness of interventions. As part of an ongoing partnership, OHBWC and the US National Institute for Occupational Safety and Health (NIOSH) collaborated on the current study to determine the effectiveness of a key program in which OHBWC provided matching funds to insured employers to implement OSH engineering controls.

METHODS AND MATERIALS

The Ohio Bureau of Workers' Compensation Safety Intervention Grants Program

The OHBWC is the largest of four exclusive state-run WC systems in the US and provides WC insurance for approximately two-thirds of Ohio workers. For the last 15 years, the OHBWC has been supporting several large-scale OSH intervention programs and services designed to improve primary through tertiary prevention at insured employers. For example, in 1999 OHBWC initiated the Safety Intervention Grants Program (SIG) to provide matching funds to insured employers to implement OSH engineering controls and measure effectiveness [Ohio Administrative Code, 2006]. From 1999 to 2009, grants ranged from a 2:1 to 4:1 OHBWC to employer match in funds, with up to $40,000 per grant. Over the history of the program, OHBWC has provided funds for over 1,800 interventions with an average annual total of $3 million in matching funds. As part of the SIG program, OHBWC consultants work closely with employers to develop proposed interventions, submit applications, and verify that they have been implemented fully in the workplace. As a part of the application process, an OHBWC consultant also conducts an onsite comprehensive safety assessment and five-year claims history review, and may also recommend steps to reduce identified hazards.

Beginning in 2003, OHBWC required that participating SIG employers identify WC claims and person-hours that were associated with the employees who would be directly affected by the implementation of the intervention for a two year baseline period pre-intervention. Employers were asked to report on the total person-hours worked by this population, regardless of what task they were performing. Post-intervention, the employer reported quarterly to OHBWC the WC claims and person-hours for employees affected by the intervention for a two year follow-up period. Employers used the date of implementation of the control equipment as the beginning of the post-intervention reporting period. The time gap between the end of the pre-intervention period and the beginning of the post-intervention data reporting periods varied by employer. From 2003 to 2009, the median gap was 4.5 months, and 95% of the gaps were under one year. The employer also reported their yearly average total number of employees (both part- and full-time) as part of the Ohio Quarterly Census of Employment and Wages (QCEW). To participate in the SIG program during the majority of the examined 2003–2009 implementation period, employers were required to have at least one WC claim pre-intervention that could have been prevented by the proposed intervention. Employers after July 2009 were not required to have a pre-intervention claim. Approximately 83.5% of submitted SIG applications were accepted for funding from 2003–2009.

In early 2012, NIOSH acquired data from OHBWC for a census of all 468 employers who were approved for grant support in the period 2003–2009. All employers had implemented the interventions and had completed the necessary follow-up documentation. NIOSH excluded any claims that were disallowed or dismissed by OHBWC (109 claims, 3.8%) and compiled the following 2001–2011 pre-and post-intervention WC metrics for all participant employers for the employees affected by the intervention:

- WC claim frequency rate (both medical-only and lost-time claims) per 200,000 affected employee hours [100 full-time worker equivalents (FTEs)]: The post/pre ratio of this outcome represents the degree to which the intervention prevented injury-illness from occurring relative to the hours worked among affected employees. It is the basic measure of primary prevention effectiveness.
- WC claim paid cost per 2,000 affected employee hours (approximately 1 FTE): The post/pre ratio of this outcome is a function of both change in claim frequency and change in cost per claim among affected employees. It is a useful metric for gauging the overall, per-employee financial impact of interventions.
- Geometric mean paid cost of affected employee WC claims: The post/pre ratio of this outcome represents the degree to which the intervention changed the expected claim cost severity among affected employees. This is only a partial measure of cost, but gives some insight into the impact on cost due to changes in individual claim cost severity versus changes in claim frequency.

Employer Size, Industry, and Sector

QCEW data were used to create two employer size groups (small, 1–99 employees, large, ≥100 employees) using the yearly average number of part- and full-time employees reported by the employer for the two-year pre-intervention period. These categories were chosen because they produced a fairly equivalent number of employers in each group (small n =242; large n =204). Specific industries were defined by two to three digit North American Industry Classification System (NAICS) codes for employers as reported in the QCEW. NAICS codes were also grouped in NIOSH industry sectors for some analyses.

Intervention Category

Intervention categories were consensus-coded by two certified professional ergonomists prior to analysis and without reference to the WC outcomes for each intervention. The coders based decisions on summary narrative information about each intervention (including keywords such as “lift table” and equipment brand names) as well as detailed case study information about the intended prevention purpose of the intervention. Intervention type categories were based partially on modified 2–3 digit source codes from the Occupational Injury and Illness Classification Manual Version 2.01 [Bureau of Labor Statistics, 2012a]. Additional detailed information on the intervention coding structure is provided in the Supplemental Online Material.

Specific interventions were classified into four categories. First, the ergonomic category included interventions (material handling equipment, patient handling equipment, and other ergonomic equipment and tools) intended to reduce risk factors (overexertion, awkward postures, excessive force, contact stress, and vibration) for work-related musculoskeletal disorders [NIOSH, 1997]. Second, the safety category included interventions (scaffolding, slip resistant flooring, and other equipment including specialty saws and machine guarding) intended to reduce acute accidents (caused by falls, struck by/against objects, and caught between/compressed by events). Third, the ventilation category included interventions (stand-alone ventilation systems or machinery and powered equipment with built-in ventilation) intended to reduce airborne contaminants. Finally, the multiple-purpose category included interventions intended to reduce more than one hazard (ergonomic, safety, and/or airborne contaminants).

Cost Valuation Approach

A basic concern with evaluating WC cost trends over time was that older claims are allowed more time to develop costs than newer claims and therefore tend to have higher reported costs. To make the measurement of costs more consistent across years, claim cost data were limited to paid medical costs and paid indemnity benefits (compensation for lost wages) valued 30 months after January 1 of the calendar year in which the claim occurred. The paid 30-month costs do not represent the ultimate cost of claims. Another measure of claim costs, called factor-adjusted costs, takes into account the ultimate costs of all claims. For example, another study of a large sample of OHBWC claims data determined that the factor-adjusted costs for calendar year 2009 were approximately three times as high as paid 30-month costs [Wurzelbacher et al., 2013].

OHBWC sponsors two main programs that impact the cost of claims reported in their database. The first program allows insured employers to pay first dollar medical costs up to a specified limit for medical-only claims. Only medical paid costs in excess of this limit are reported to OHBWC. A second program allows insured employers to pay first dollar indemnity (wage replacement) costs, which are not reported to OHBWC. Employers that participated in either of these two programs were included in claim frequency analyses, but excluded from the analyses of claim costs. Claims with $0 in total paid costs (not impacted by the two programs above) were included in both the frequency and cost analyses (127 clams, 4.7%).

Data Analysis

All outcomes were analyzed with multivariable models to account for temporal trends. For the claim frequency rate analysis, Poisson regression with repeated measures was performed. For the claim cost per FTE analysis, a two-part model was used, which is fully described in the Supplemental Online Material. This type of model is useful in analyzing data with a large proportion of zeroes. In the first part of the analysis, the probability of observing a $0 cost per FTE is estimated, and in the second, the mean cost per FTE is estimated for those employers with cost >$0. For the WC cost per claim analysis, a linear regression model with repeated measures was used. In addition, for the WC cost per claim analysis, since the cost data for this analysis was skewed, it was transformed using the natural log before modeling and reported as geometric means, which generally approximate the median of the distribution. To address taking the natural log of a $0 claim, $5 was arbitrarily added to the cost of every $0 claim. One employer with an extreme outlier claim (that was an order of magnitude larger than the next highest claim) was excluded from both cost analyses. All models controlled for changes in rates over time that may have occurred independently of the interventions. This method measures pre–post changes relative to a time trend that is based on data from program participants rather than a separate comparison group, thus avoiding bias caused by differences in time-invariant characteristics between employers who applied for and received safety grants and those who did not. Differences in employer characteristics that vary over time would also not bias the results, unless the variation is correlated with the intervention, as might be the case if other, unrelated safety efforts tended to be undertaken at the same time as the grant-supported intervention. All analyses were conducted using two models to control for the time trend. The 1st model assumed constant/linear cost trends over time but included a factor that accounted for the random effects of each employer's paired pre/post data. The 2nd model did not restrict costs to a yearly trend, and instead used dummy variables for each year to allow background changes in costs to vary independently by year. We found only slight differences between the two different model results and report only the 1st model here since it allows us to better summarize the independent time effect on outcomes.

Analyses were conducted initially with all available data and then stratified by employer size. Analyses were then conducted for specific industries, and interventions. Since industry and intervention type were strongly correlated with year, due to the changing emphases of the SIG program, these analyses were conducted without controlling for changes in rates over time that may have occurred independently of the interventions. Additional information on the regression modelling approach is provided in the Supplemental Online Material.

Post-hoc Analyses

Five post-hoc analyses were conducted to evaluate the possible influence of regression-to-the mean (RTM) effects, employer under-reporting of WC claims for affected employees, and limits to generalizability. To investigate possible RTM effects, a series of post-hoc analyses were conducted [Barnett et al., 2004]. We first compared the claim frequency rate results of high- and low-rate groups (low-rate was defined to be ≤ the median rate) using the same regression model as in the main analysis. The second post-hoc analysis examined the time path of claim rates, cost per FTE, and geometric mean cost per claim at a finer level of detail—annually in the pre-intervention period, and quarterly in the post-intervention period. The objective was to determine whether there was evidence of an unusual spike in rates just prior to intervention, and whether this was immediately followed by a similar decline that could be explained by random variation in rates over time rather than intervention. In this second analysis, since employers reported affected employee data in 2-year sums for the pre-intervention period, an assumption was made that the affected employee hours were divided equally between the two years. Post-intervention claims data were reported by the employer quarterly. In this analysis, all regressions again controlled for repeated measures and changes over time that may have occurred independently of the interventions.

Third, we performed a similar analysis as just described, except examining the entire employer. This allowed us to examine two more years before the 2-year pre-intervention period, as well as two years after the 2-year post-intervention period, to evaluate whether there was a trend upward in the rates and costs of the entire employer before the intervention, that could explain selection into the program. Employer-level data is reported in calendar years, and yearly rates were calculated in relationship to entrance into the program. The first year before entrance into the program (labeled "−1") was represented by the last calendar year with at least nine months before the application date, and the first year after entrance into the program (labeled "+1") was represented by the first calendar year with at least nine months after the implementation of the intervention. For many employers, this left one calendar year that represented some mixture of pre and/or post periods and the intervening time between application and implementation. These calendar years were labeled "0".

To evaluate the possibility that employers may have under-reported WC claims for affected employees post-intervention, a fourth post-hoc analysis was conducted to compare the unaffected employee WC claim frequency rates pre- and post-intervention. One way that employers could have under-reported claims for affected employees is by assigning their claims to the unaffected group. We hypothesized that the effect would be most pronounced for smaller employers where a few misattributed claims could elevate claim rates among unaffected employees to a greater degree. To test this hypothesis, the total number of employees reported by the employer in the QCEW for the pre- and post-intervention periods was multiplied by 2,000 to estimate total annual employee hours, and then the reported affected employee hours were subtracted to estimate unaffected employee hours. The 2,000 hr assumption likely results, on average, in an underestimate of rates, since it does not take part-time work into account. However, this does not bias the estimate of percent change in rates. Poisson regression with repeated measures analysis was again performed to control for changes in rates over time that may have occurred independently of the interventions. Estimation of unaffected employee claim frequency rates was also used to compare claim rates of affected and unaffected employees in the pre-intervention period. This may be useful for understanding how the affected employee group was selected for the intervention.

To evaluate the possibility that participant employers may have had higher or lower injury rates and costs than non-participants (which would limit generalizability), and to examine how any differences from non-participants may have changed over time, we conducted a fifth post-hoc analysis by analyzing the experience modification ratings (EM) of the participant employers. The EM is a traditional insurance metric that compares the actual past WC losses of the employer versus the expected losses for that employer's specific industry [as defined by National Council on Compensation Insurance (NCCI) class code] in the state of Ohio.

The OHBWC EM is different from most EM formulas used in other states in that much more weight is placed on the cost of WC claims as opposed to their frequency [OHBWC, 2012]. EMs are revised each year on July1, and are based on data for a 4-year "experience" period ending 1.5 years earlier. The EMs were classified into pre- and post-intervention years relative to entrance into the program as described above, based on the last year of the experience period. A series of median, annual EMs was constructed to reflect the relative level and trend in the overall claims experience of grant recipient employers, prior to and following intervention. A second series of EMs was also constructed that was based, where applicable, on EMs that were assigned to employers based on their membership in group plans. While each employer has their own individual EM, some employers have another EM that is assigned to all employers in their group, and this is the one that is used to compute premium payments and may be more influential in employer decision making. Approximately 46% of OHBWC-insured employers participate in group rating or other programs that discount EMs.

All analyses were conducted using SAS® version 9.3 (SAS Institute, Inc., Cary, NC). This research was approved by the NIOSH Institutional Review Board. The requirement for informed consent was waived because the study involved the analysis of coded and previously collected WC and program evaluation data.

RESULTS

Participant Employer and Affected Employee Demographics

Participant employer sizes ranged widely (1–24 employees, n =59; 25–49 employees, n =73; 50–74 employees, n =65; 75–99 employees, n =46; 100–149 employees, n = 61; 150–199 employees, n =40; 200–249 employees, n = 24; 250 +employees, n =81).

The number of affected employees at each employer also ranged widely (mean =49, SD =188, median =18). The ratio of affected to total employees differed by employer size. In small employers (1–99 employees), the median percentage of affected employees was 35% of the total number of employees. In large employers (100+ employees), the median percentage of affected employees was 15% of the total number of employees.

Pre- and Post-intervention WC Metrics

Table I provides summary statistics on the affected employee WC claim outcomes for the 468 employers from 2001–2011. For every year of intervention, there was a decrease in the rate between the pre- and post-intervention periods. There was also a general tendency for rates to decrease over time independent of intervention, as can be seen by the change over time in pre-intervention rates.

Pre- and Post-intervention Regression Results

Claim frequency and cost—Table II compares the change in WC claim frequency rates per 100 affected FTE over time for all industries combined using Poisson regression with repeated measures and lists the parameters as rate ratios. Overall, the total (medical-only and lost-time claims) WC claim rate per 100 affected FTE decreased by 11% per year, independently of intervention. However, in a given year there was an additional 66% difference between an employer with an intervention and an employer without an intervention. Both of these rate decreases were statistically significant (P <.05). The lost-time WC claims rate per 100 affected FTE decreased by a greater degree (78%) post-intervention. Table II also compares the change in WC paid cost per affected FTE and WC paid cost per affected employee claim over time and lists the parameters as rate ratios and geometric mean ratios. Note that there were generally insignificant time trends for these outcomes independent of the intervention. However, the WC paid cost per affected FTE was significantly (P <.05) lower (81% less) with an intervention in place than without an intervention. The geometric mean paid cost per affected employee WC claim was also significantly (P <0.05) lower (30% less) post-intervention. The changes in all outcomes with and without an intervention in place are summarized in Figure 1.

Employer size, industry, sector, and intervention group—As shown in Table II, reductions in the frequency of WC claims per 100 affected FTE and WC cost per affected FTE were significant (P <.05) for both smaller employers (1–99 employees) and larger employers (≥100 employees), but were greater for smaller employers. Table III reports results by NIOSH industry sector and Table IV reports results by intervention group. Since the year of intervention did not vary sufficiently within individual industries and intervention groups, these analyses were conducted without controlling for changes in rates over time that may have occurred independently of the interventions. Results in Table II indicate that the year effect alone accounted for a 22% decline in the affected employee WC claim frequency rate per 100 affected FTE for every two year period independently of intervention, suggesting that the post-intervention reduction effect sizes shown in Tables III and IV for this outcome may be overestimated.

Many industries and interventions demonstrated reductions far greater than the background rate changes. For example, 90% (9 of 10) of NIOSH industry sectors (all except Construction) and 75% (3 of 4) of intervention major groups (ergonomic, safety, and multiple-purpose) exhibited statistically significant reductions of greater than 50% in WC claim frequency per 100 affected FTE post-intervention. Overall, 60% (6 of 10) of industry sectors and 75% (3 of 4) of intervention major groups (ergonomic, safety, and multiple-purpose) exhibited statistically significant reductions of greater than 50% in WC paid cost per affected FTE post-intervention. Less impact was demonstrated for WC geometric mean paid cost per affected employee claim, with just 20% (2 of 10) of industry sectors and 50% (2 of 4) of intervention major groups (ergonomic and multiple-purpose) exhibiting statistically significant reductions in this outcome after the intervention.

Post-hoc analyses—Higher pre-intervention claim rates were associated with greater rate declines in the post-intervention period, as shown in both a scatter plot and in a comparison of regression results for firms with high and low rates in the pre-intervention period. This relationship is expected even in the absence of RTM influence on the estimated intervention impacts (as explained in the discussion below). These results are reported in Figure S1 and Table SV in the Supplementary Online Materials.

Table Va presents the post-hoc analysis results where the data were divided into yearly rates, presenting the rate ratios in reference to the first year of the pre-intervention data. This analysis indicated that both the WC claim frequency rate per 100 affected FTE and geometric cost per claim increased slightly during the pre-intervention period (from year 1 to year 2), though the change was small and not significant. The cost per FTE decreased slightly from year 1 to year 2, but again the change was small and insignificant. In the first post-intervention year (year 3) the rate dropped significantly for all outcomes, followed by an additional significant drop for the claim rate and cost per FTE in the second post-intervention year (year 4). When the post-intervention data were divided into quarter-annual groups (Table Vb), all outcomes dropped sharply in the 1st quarter post-intervention, and then declined steadily compared to the pre-intervention year one for the remaining quarters post-intervention. There was an average decline of 17% per quarter in affected employee WC claim frequency rates post-intervention [RR: 0.83 (0.74, 0.92), *P*-value =0.0006].

Table VI presents the post-hoc analysis results comparing the WC claim frequency per 100 unaffected FTE rates pre-and post-intervention. Results indicated that WC rates for unaffected employees increased slightly post-intervention, but this change was not significant. The rates for unaffected employees in smaller employers (1–99 employees) decreased slightly while larger employer unaffected employee rates increased slightly, but these changes were not significant. Comparison of pre-intervention rates of affected versus unaffected employees (not shown) indicated that rates for unaffected employees were approximately 70% higher, while costs per employee among affected and unaffected employees were similar.

Figure 2 presents results of the two post-hoc analyses of overall employer-level data. In the first two panels of Figure 2, the results of the analysis of EMs indicated that employers who participated in the SIG had rising EMs before the intervention, although the trend is more slight for the series based exclusively on individual employer EMs that reflect actual experience, than it is for the series that reflects EMs assigned under group policies. While the EMs in year one best reflect claims experience in the four years before grant application, these EMs were not reported to employers until after grant application. Since EMs are calculated with a lag, the last EMs that were reported to employers by the time of the grant application would have been those in year 3 or year 2, depending upon time of year of the application. The lower panels of Figure 2 display trends in claim rates and cost per FTE for the overall workforces of participating employers.

DISCUSSION

The results from this study suggest that among participating employers the insurer-supported OSH engineering control program was effective in significantly reducing WC claim frequency per 100 affected FTE, WC paid cost per affected FTE, and WC paid cost per affected employee claim after controlling for time trends independent of intervention. This study builds on prior research by demonstrating that primary prevention approaches are effective in reducing reported injury outcomes. Significant reductions in WC claim frequency per 100 affected FTE and WC paid cost per affected FTE were also shown for a wide range of employer sizes, specific industries, and ergonomic/safety intervention types. The high level of effectiveness observed across such a wide range of intervention types suggests that results may have been driven in part by a stronger overall focus on the safety of the affected employee groups. This may have resulted from work with OHBWC consultants and the process of periodic reporting of claims and program activities to OHBWC.

Control for Downward Time Trend in Claims

Of the intervention studies [Marras et al., 2000; Owen et al., 2002; Fujishiro et al., 2005; Alamgir et al., 2008; Park et al., 2009] that have investigated the impact of engineering controls on injury rates, few [such as Park et al., 2009 and Fujishiro et al., 2005] directly controlled for the injury trends over time that occurred independently of the interventions. Recent Bureau of Labor Statistics (BLS), NCCI, Washington State, and OHBWC data have demonstrated that overall Occupational Safety and Health Administration (OSHA) recordable injury/illness and WC claim numbers and rates are declining significantly in most industries. For example, a study by NCCI [NCCI, 2010] found 4% average annual declines in the rates of lost-time WC case rates, for a total decline of 57% from 1990 through 2009 while Washington State found declines of 5.9% per year for all claims [Silverstein, 2007]. From 2000 to 2009 the number of claims reported in the OHBWC claims system also dropped by 47.6% [Tarawneh et al., 2013].

There is no clear consensus on why these rates and numbers are declining, but some researchers have suggested this could be due to under-reporting [Morse et al., 2005], economic reasons [NCCI, 2012], or “advances in automation, technology, and production” and “emphasis on workplace safety and loss control” [NCCI, 2010]. Regardless of the cause, it is important in effectiveness research to control for the WC change over time that may occur independently of the evaluated intervention. This study was able to show that over and above the general WC claim decline, total claim rates (medical-only and lost-time claims) declined an additional 66% in the affected employee groups post-intervention. This study also examined the impact of engineering controls in a wide range of employer sizes and provides key evidence that targeted engineering interventions are an effective tactic for reducing WC claims among both smaller (1–99 employees) and larger employers.

Assessment of Impacts for Wide Variety of Industries and Control Equipment Types

Most prior intervention studies have demonstrated intervention effectiveness in a specific industry such as healthcare [Owen et al., 2002; Collins et al., 2004; Fujishiro et al., 2005; Park et al., 2009]. The current study evaluated effectiveness in a wide range of industries (10 major industry sectors). As a whole, this study provides evidence that engineering interventions were implemented successfully in wide variety of applications and industrial settings.

Many of the intervention studies that have been conducted in the past focused on a single type or narrow range of controls such as ergonomic patient handling devices [Owen et al., 2002; Collins et al., 2004; Fujishiro et al., 2005; Park et al., 2009]. The current study demonstrated significant reductions in WC outcomes for a wide range of ergonomic, safety, and multiple-purpose interventions across many industries. For example, ergonomic interventions were utilized most in the Manufacturing and Services (except Public Safety) sectors but were implemented in almost every NIOSH industry sector. The significant reductions for ergonomic and safety equipment were expected, given that these types of interventions target the most common occupational exposure events (such as overexertion, repetitive motion, bodily reaction, slip trip falls, struck by/against, caught in/compressed by), which together account for the majority of injuries/illnesses [BLS, 2012b] and WC costs [Liberty Mutual, 2013]. This provides evidence that many types of specific engineering controls are effective in reducing WC outcomes for affected employees, and that the same intervention type is effective in multiple industrial settings.

By contrast, ventilation controls were associated with a significant post-intervention increase in WC paid cost per affected FTE and WC paid cost per affected employee claim post intervention. This is understandable, given that there are few WC claims related to air contaminant exposures. This finding does not establish that the ventilation controls were not effective in reducing contaminants or improving worker health outcomes. Rather the 2-year post-intervention WC outcomes were not sensitive enough to capture the effectiveness of the ventilation controls and/or the time period selected was too short to observe any measurable change in occupational disease incidence. The negative finding for ventilation controls actually provides support for the integrity of the study since reductions in WC outcomes would not necessarily be expected for this type of workplace change.

The range of effectiveness data by specific industry and intervention (see Tables III and IV and Table SI–Table V) provide useful information for employers to consider when conducting analyses prior to implementing specific engineering control projects. Several cost-benefit calculators have been developed recently [Goggins et al., 2008; IWH, 2009], but a missing parameter is often the expected range of effectiveness for a given industry and intervention. As a reminder, the analyses for specific industries and interventions did not control for the time trends independent of the intervention. The very large effect sizes may have also been influenced in part by RTM effects and other study limitations discussed below. Therefore, for practitioners, it may be most appropriate to focus on the lower bound of the confidence interval as the expected effectiveness of a given engineering control for planning purposes.

Support for Development of Similar Safety Grant Programs at Other WC Insurers

The effectiveness of the entire SIG program also provides useful information for insurers who may consider implementing similar matching grant programs. Funding support by insurers for engineering controls is rare. Six state insurance bureaus support some form of matching fund programs, but only four provide funds that can be used for engineering controls (WA, NY, ND, and OH). The others provide matching funds for training programs (MA, OR). No known commercial insurers offer similar programs to support engineering controls. For exclusive state-funds (OH, WA, ND, and WY), the business model is such that the insurer will insure the employer as long as they are in business or the employer does not self-insure. Thus, primary loss prevention may tend to play a greater role in risk management for the exclusive insurer. This study indicates that supported engineering programs such as the SIG should continue to be a focus for such exclusive insurers. For example, OHBWC recently expanded annual funding for the SIG from approximately $4–12 million based in part on the apparent effectiveness of the program.

For US commercial insurers, employers are generally bound to their insurer only by annual policies that must be renewed. Although primary loss prevention is still a focus, most commercial insurers also emphasize loss reduction to control claim costs, risk selection to choose which employers to insure, and experience rating systems to set appropriate premiums and derive profit. Although supported engineering control programs may be less attractive initially to commercial insurers, this study did demonstrate that the claims reductions occurred immediately after implementation of the intervention. This suggests that the return-on-investment may still be attractive enough on a group if not individual employer level from the commercial insurer perspective. It may also be possible for commercial insurers to develop special contracts such that, if an employer chooses to insure with another insurer after one year, that the insured employer must pay back matching funds. Alternative arrangements, such as providing premium discounts for demonstrated engineering control implementation at the insured employer, may also be possible for commercial insurers. Such arrangements would likely require the approval of the WC bureau in the US state where the insured employer is located. State WC bureaus could also possibly provide incentives to encourage insured employers and insurers to implement similar supported engineering control programs.

LIMITATIONS

Basic Study Design

There are several limitations to the analyses presented in this paper. First, this study used a pre–post design that lacks randomization and a true control group. The drawbacks of this design are mitigated by the fact that interventions occurred over a wide range of dates, such that there is no common, independent change at a point in time that coincides with intervention. In addition, the baseline time trend against which claim rates and costs are measured, is calculated with program participant data rather than with data on non-participants who may have been different. A remaining concern is that the timing of intervention may have coincided with other changes for the affected employee group. The lack of any dramatic changes in claim rate among unaffected employees suggests coincident changes were not great at the overall employer level.

Possible Influence of RTM on Results

A second main limitation is that employers may have applied for grants at a time when claim rates and costs were high for the affected employee group, due in part to a random upward fluctuation in rates. If so, rates would have tended to fall in the post-intervention period due to a RTM effect rather than intervention effectiveness. The possibility of an RTM effect on the results could have been increased by a rule, in place for most of the 2003–2009 period, that employers in the SIG program had to have at least one WC claim during the pre-intervention period that could have been prevented by the proposed intervention. This possibility was mitigated by assessing WC outcomes for 2-year rather than 1-year periods, pre- and post-intervention.

Full and accurate measurement of the potential contribution of RTM to the observed pre–post decline requires determination of the difference between the normal or expected rate for the affected employees and their actual rate in the pre-intervention period. Ideally, this might be done by examining their trend in rate over many years prior to intervention, or by examining the long-term trend in rates of a closely comparable set of employees. Data of this kind is unavailable in the current study, but some of the post-hoc analyses provide useful evidence.

In the first post-hoc analysis (Figure S1 and Table SV), pre–post-intervention WC claim frequency rate changes were observed to be greater for employers with higher pre-intervention rates. However, this would be expected even in the absence of a RTM impact on the results of the study. Higher pre-intervention rates are always associated in some degree with a greater tendency for subsequent decline, due to the role of random variation in their higher rates. The question is whether the study population contains a balanced representation of groups with random increases and decreases in rate prior to intervention.

The second post-hoc analysis examined the affected employee WC claim frequency rate and cost data divided into yearly and quarterly rates (Table Va, b). This time path of claim rates and costs does not rule out RTM, but neither does it support an RTM explanation of the results. First, there was no notable increase in rates or costs in the year before intervention over the previous year. However, employers may instead have taken a longer view, considering both pre-intervention years, or a longer span of years, and all of these years together may have seen a random increase above the central tendency. We do not have the data to determine whether this was the case. Yet, even if employers did take a longer view, it would still have been logical to expect employers to place the greatest weight on their claims experience in the immediately preceding year. Second, the distinct downward trend in claim rate and cost per FTE in the post-intervention period (Table Vb) is not compatible with the RTM theory, in which rates and costs would have the same expected value in each successive post-intervention period, or track general time trends in risk levels. The initial, post-intervention declines could still have been at least partly due to RTM. However, it would be most reasonable to assume that a program of apparent effectiveness in the second year was also at least somewhat effective in the first year, especially since the type of safety and ergonomic equipment funded by the program would generally be expected to have impacts in less than one year.

There is some evidence to suggest that some employers may have been motivated to participate not by increased claim rates and costs for the affected employees, but by their overall claim rates and costs. First, in the pre-intervention period, overall employee claim rates were 1.7 times higher on average than in the affected group, while the total employee cost per FTE was about the same on average as in the affected group. Second, while the evidence is somewhat mixed, the time path of overall claim rates, cost per FTE, and the EM suggests that employers may have perceived an upward trend prior to the grant. Claim rates (Figure 2) increased from year 4 to year 3 before the grant, but were declining slightly thereafter, before the grant. Cost per FTE increased substantially from year 4 to year 3 before the grant, and then again in the year before the grant, before dropping even more substantially in year 0. This is suggestive of an RTM effect on the overall employer level with respect to costs, although the post-intervention period as a whole does not suggest a downward return to trend, and the year 0 contains a mixture of pre- and/or post-intervention periods as well as the intervening time between pre-and post-intervention periods. The presence of an RTM effect on the employer level does not necessarily imply an RTM effect for the affected employee group, for which we saw a slight decline in cost per FTE in the last pre-intervention year, rather than an increase. However, some of these upward trends occurred previous to the pre-intervention period, and it is possible that these were shared by the affected employee group.

It is notable that the decline in the individual employer EMs was modest after intervention, and that group policy EMs did not decline post intervention. However, EMs are designed to reflect changes in claims experience only partially, due to the small size of the employers, and changes in group policy EMs may also be due to changes in group policy membership and rules governing group policy pricing. In addition, the safety grants would be expected to have a relatively modest observable impact on EMs, since the affected work group was 35% of the workforce in small employers and only 15% in large employers.

It may seem surprising that interventions were not targeted at an employee subgroup with especially high rates and costs. One possibility is that the highest employer risks required more extensive process changes that were not always addressed through the program. Based on OHBWC input, the choice of intervention depended not just on the magnitude of risks but on the feasibility of reducing those risks within the scope of the SIG program (which is focused on placing of commercially available engineering controls within defined employer processes with a matching budget of $40 k or less).

Another possibility is that, since costs per employee were similar, but claim rates lower among the affected employees, the relatively high cost per claim among affected employees could have made them a more visible target for intervention. This visibility could have been heightened if the higher average cost per claim was driven by a few, very expensive claims. If affected employee groups were selected partly on the basis of a few high cost claims, this could have led to an RTM effect with respect to cost per claim, and helped explain why we observed a higher percentage decline in cost per employee than in the claim rate. However, this does not appear likely, since there is little difference between claim rate decline and cost per employee decline when we focus only on more costly lost-time claims. The claim rate decline itself would not have been affected by this selection criterion.

In sum, the time trends in affected employee claim rates and costs, both pre- and post-intervention, did not exhibit patterns that would have been expected if RTM effects were the main driver of the results. In addition, the evidence indicated that affected employees were not selected for participation on the basis of higher claim rates and cost per employee than their peers in the workplace, and that, based on EMs, employers who participated had only slightly higher claim costs and rates than peers in their industry. There remains a question about whether RTM effects might nevertheless have explained part of the observed post-intervention declines, because data is not available to determine whether claim rates and costs in both years prior to intervention were random upward departures from the long term trend. This possibility is reduced, given the relatively low claim rates and similar costs among affected employees, since any random increase would have to have been from a still lower level. On the other hand, the time path of overall claim rates, costs, and EMs shows an increase before the pre-intervention period that could have been shared by the affected employee group. While the affected employee group within the employer may have been targeted in part, because of some highly visible, expensive claims, this is a possible explanation for only a small portion of the post-intervention changes in cost per claim. Thus, it is possible that an RTM effect contributed to the results, although the post-hoc analyses do not, on the whole, provide very much support for the RTM having a substantial influence on the observed decline in WC outcomes post-intervention.

Other Limitations

Another potentially important limitation was that SIG employers self-reported WC claims associated with the affected work group pre- and post-intervention. It is possible that the employers' expectations of intervention success and the desirability of demonstrating success could have influenced their reporting. There may have also been disincentives for reporting in some employers such as "safety bonuses" for supervisors or employees who do not report. One way for this to have occurred is that employers under-reported claims for affected employees after the intervention by assigning some of their claims to the unaffected group. This would have produced post-intervention increases in claim rates among unaffected employees, especially among smaller employers, since the affected group is a greater proportion of their employees. However, post-hoc analysis (Table VI) indicated that the rates for unaffected employees did not change significantly post-intervention, and the rates for smaller employer unaffected employees actually decreased slightly post-intervention. This analysis provides some assurance that the employers were not under-reporting claims for the affected employees.

An additional analysis issue was that the claims being reported were all claims associated with the affected employee group and not just those claims directly preventable by the intervention. This approach tends to reduce the power to detect injury reductions, but the data collection method was equally applied pre- and post-intervention, and there should have been no net bias towards reduction post-intervention. Furthermore, one advantage of having the employer report all claims for the affected work group was that the employer was not being asked to make a decision about whether the intervention could have prevented a particular claim, thus removing another possible source of bias and inconsistency in reporting.

Finally, this study focused only on employers who elected to apply for the grant program and received funding. Thus the study group was self-selected, and the findings may not be generalized to employers who do not seek to participate in programs similar to the SIG. Based on the EM analysis, employers who participated had claim costs that tended to be just slightly higher than other employers in their industry and size class (individual EM averaging 1.04 for the 4-year experience period immediately preceding intervention, see panel b in Figure 2). However, OHBWC personnel involved in the program suggest anecdotally that participating employers tend to be those who participate in other supported programs such as OHBWC consultation services, and have above-average commitment to improving safety. Thus, this study's results may be most generalizable to employers that have demonstrated some prior safety success and interest.

CONCLUSIONS

The study results suggest that the insurer-supported engineering controls were effective in reducing WC claim frequency per 100 FTE, WC cost per FTE, and WC cost per employee claim among employees designated by employers as affected by the interventions. While it is still possible that a portion of the observed decline in WC outcomes was due to an RTM effect, available evidence suggests that affected employee groups were not selected for participation based on random increases in outcomes prior to the intervention. Given the lack of evidence for RTM effects and the large observed declines in claim rates and cost per employee, it is reasonable to conclude that the effects of the interventions were substantial. Reductions were substantial as well for many individual industries, employer sizes, and intervention types. This study provides additional evidence that engineering controls for safety and ergonomic risks are effective in reducing WC claims and costs, and that supported primary prevention programs may be justifiably initiated or expanded by other employers and insurers (both state-based and commercial insurers). Secondly, there is evidence that some specific interventions are more effective than others and targeted funding of these particularly effective equipment types may be warranted. Because substantial impacts were found for most intervention types, there is also a suggestion that the safety grant program process may have improved safety by increasing the overall focus on the safety of affected employees, as well as through installation of the funded safety equipment.

OHBWC and NIOSH are continuing to evaluate OHBWC supported OSH programs. The next steps are to evaluate the actual return-on-investment of the SIG program from multiple perspectives (e.g., insurer, employer, and society). This includes investigation of intervention impacts on EMs (and corresponding premium savings), process quality, and productivity. These ongoing studies will provide information (such as expected payback period) for insurers and other employers who may be deciding to implement a similar supported engineering control program. This is especially important for commercial insurers, who expect that as a result of intervention there will be a reduction of claims frequency and/or costs within the timeframe of annually renewed policies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research was supported by NIOSH intramural funds, awarded as part of the competitive National Occupational Research Agenda process.

References

Alamgir H, Yu S, Fast C, Hennessy S, Kidd C, Yassi A. Efficiency of overhead ceiling lifts in reducing musculoskeletal injury among carers working in long-term care institutions. Injury. 2008; 39(5):570–577. [PubMed: 18377908]

Barnett AG, van der Pols JC, Dobson AJ. Regression to the mean: what it is and how to deal with it. Int J Epidemiol. 2004; 34(1):215–220. [PubMed: 15333621]

Bigos SJ, Holland J, Holland C, Webster JS, Battie M, Malmgren JA. High-quality controlled trials on preventing episodes of back problems: systematic literature review in working-age adults. Spine J. 2009; 9(2):147–168. [PubMed: 19185272]

Brewer, S.; King, E.; Amick, B.; Delclos, G.; Spear, J.; Irvin, E.; Mahood, Q.; Lee, L.; Lewis, C.; Tetrick, L., et al. A systematic review of injury/illness prevention and loss control programs (IPCs). Toronto: Institute for Work & Health; 2007.

Bureau of Labor Statistics. Illness Classification Manual Version 2.01. 2012a.

Bureau of Labor Statistics. TABLE R8 Incidence rates one for nonfatal occupational injuries and illnesses involving days away from work two per 10, 000 full-time workers by industry and selected events or exposures leading to injury or illness, 2011. 2012b

Collins JW, Wolf L, Bell J, Evanoff B. An evaluation of a “best practices” musculoskeletal injury prevention program in nursing homes. Inj Prev. 2004; 10(4):206–211. [PubMed: 15314046]

Fredriksson K, Bildt C, Hagg G, Kilbom A. The impact on musculoskeletal disorders of changing physical and psychosocial work environment conditions in the automobile industry. Int J Ind Ergonomics. 2001; 28:31–45.

Fujishiro K, Weaver JL, Heaney CA, Hamrick CA, Marras WS. The effect of ergonomic interventions in healthcare facilities on musculoskeletal disorders. Am J Ind Med. 2005; 48(5):338–347. [PubMed: 16254947]

Goggins RW, Spielholz P, Nothstein GL. Estimating the effectiveness of ergonomics interventions through case studies: implications for predictive cost-benefit analysis. J Safety Res. 2008; 9(3): 339–344. [PubMed: 18571576]

Institute for Work and Health. [Accessed 4/19/13] Health and Safety Smart Planner. 2009. from http://www.iwh.on.ca/smart-planner

Liberty Mutual Research Institute. 2013 Workplace Safety Index. 2013

Luijsterburg PAJ, Bongers PM, de Vroome EMM. A new bricklayers’ method for use in the construction industry. Scand J Work Environ Health. 2005; 31(5):394–400. [PubMed: 16273966]

Marras WS, Allread WG, Burr DL, Fathallah FA. Prospective validation of a low-back disorder risk model and assessment of ergonomic interventions associated with manual materials handling tasks. Ergonomics. 2000; 43(11):1866–1886. [PubMed: 11105977]

Morse T, Dillon C, Kenta-Bibi E, Weber J, Diva U, Warren N, Grey M. Trends in work-related musculoskeletal disorder reports by year, type, and industrial sector: a capture-recapture analysis. Am J Ind Med. 2005; 48(1):40–49. [PubMed: 15940716]

Davis J, Crotts M. National Council on Compensation Insurance Research Brief. Workers Compensation Claim Frequency Continues to Decline in 2009. 2010

Davis J. National Council on Compensation Insurance Research Brief. Workers Compensation Claim Frequency— 2012 Update. 2012

National Institute for Occupational Safety and Health. Elements of Ergonomics Programs. 1997 Publication 97–117.

[Accessed July 24, 2014] Ohio Administrative Code4123-17-56, Safety Grant Programs. 2006. http://codes.ohio.gov/oac/4123-17-56

Ohio Bureau of Workers’ Compensation State Insurance Fund Manual 2012 July 1 2012 –June 30. Columbus, Ohio: 2013.

Owen B, Keene K, Olson S. An ergonomic approach to reducing back/shoulder stress in hospital nursing personnel: a five year follow up. Int J Nurs Stud. 2002; 39(3):295–302. [PubMed: 11864653]

Park RM, Bushnell PT, Bailer AJ, Collins JW, Stayner LT. Impact of publicly sponsored interventions on musculoskeletal injury claims in nursing homes. Am J Ind Med. 2009; 52(9):683–697. [PubMed: 19670260]

Sengupta, I.; Reno, V.; Burton, J.; Baldwin, M. Workers’ Compensation: Benefits, Coverage, and Costs, 2010. Washington D.C: National Academy of Social Insurance; 2012.

Shinozaki T, Yano E, Murata K. Intervention for prevention of low back pain in Japanese forklift workers. Am J Ind Med. 2001; 40(2):141–144. [PubMed: 11494341]

Silverstein B. Work-related Musculoskeletal Disorders of the Neck, Back, and Upper Extremity in Washington State, 1997–2005. Technical Report Number 40-11-2007. 2007

Silverstein B, Clark R. Interventions to reduce work-related musculoskeletal disorders. J Electromyogr Kinesiol. 2004; 14:135–152. [PubMed: 14759759]

Tarawneh, IS.; Lampl, M.; Robins, DR.; Bentley, D. Injury Trends in the Ohio Workers' Compensation System. Published in the Use of Workers' Compensation Data for Occupational Safety and Health. In: Utterback, D.; Schnorr, T., editors. Proceedings from June 2012 Workshop. Cincinnati OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2013. DHHS (NIOSH) Publication No. 2013-147

Tveito TH, Hysing M, Eriksen HR. Low back pain interventions at the workplace: a systematic literature review. Occup Med. 2004; 54:3–13.

van der Molen HF, Sluiter JK, Hulshof CT. Implementation of participatory ergonomics intervention in construction companies. Scand J Work Environ Health. 2005; 31:191–204. [PubMed: 15999571]

Wurzelbacher, SJ.; Meyers, AR.; Bertke, SJ.; Lampl, M.; Robins, DR.; Bushnell, PT.; Tarawneh, IS.; Childress, D.; Turnes, J. Comparison of cost valuation methods for workers' compensation. In: Utterback, D.; Schnorr, T., editors. Published in the Use of Workers' Compensation Data for Occupational Safety and Health: Proceedings from June 2012 Workshop. Cincinnati OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2013. DHHS (NIOSH) Publication No. 2013-147

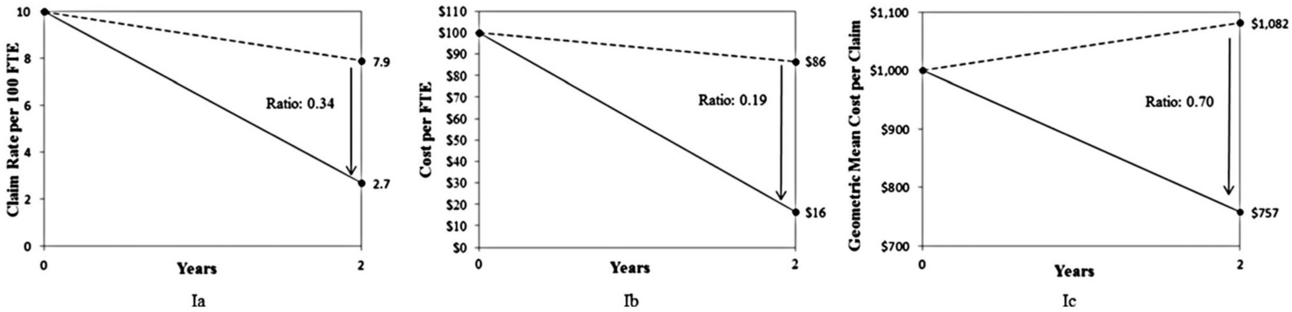

FIGURE 1.

Intervention effect illustration for each outcome (a) Claim Rate per 100 FTE vs Years. (b) Cost per FTE vs Years. (c) Geometric Mean Cost per Claim vs Years. Note: Simple values for pre-intervention outcomes were chosen as illustrations. The dotted line represents the estimated change without an intervention. The solid line represents the additional reduction estimated with the intervention in place.

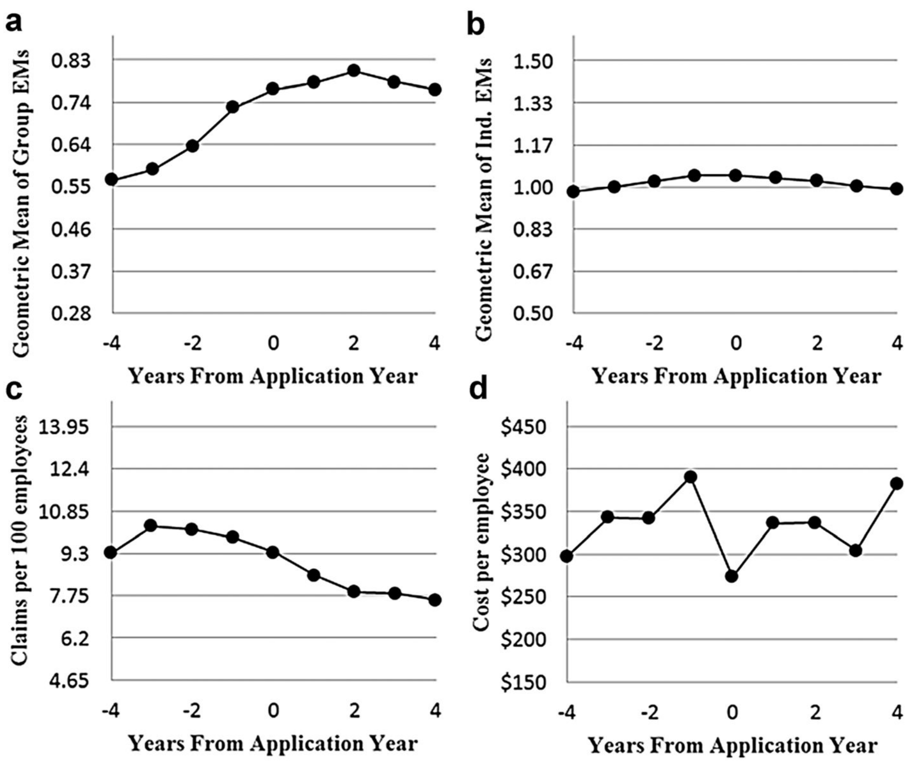

FIGURE 2.

(a) Geometric Mean of the Group EMs by year from application* (b) Geometric Mean of the Individual EMs by year from application** (c) Claim rate per 100 employees for the entire employer by year from application and (d) Total paid claim cost per employee for the entire employer by year from application. General note for entire table (a, b, c, d): Data in all four panels were classified into years preceding application and following grant implementation, with year 0 representing a mixture of pre and/or post period and the period between application and grant implementation. See the Methods section. Note for (a) *EMs used for calculation of premium. If employer participates in a group plan with other employers, the Group EM is used. Note for (b) **EMs based only on individual employer claims experience.

TABLE I

Summary Statistics on Workers' Compensation Outcomes for Affected Employees

		Pre-Intervention					Post-Intervention				
Year	**Number of employers[a]**	**Number of claims (LT)[b]**	**Claims per 100 FTE[c]**	**Cost per FTE[d]**	**Mean cost[d]**	**Median cost[d]**	**Number of claims (LT)[b]**	**Claims per 100 FTE[c]**	**Cost per FTE[d]**	**Mean cost[d]**	**Median cost[d]**
2003	11 (10)	95 (23)	13.0 (3.1)	$409	$3,649	$417	35 (2)	5.1 (0.3)	$32	$1,204	$368
2004	79 (75)	357 (110)	7.2 (2.2)	$310	$4,589	$573	230 (43)	1.8 (0.3)	$29	$1,994	$351
2005	111 (103)	563 (212)	5.7 (2.1)	$226	$4,067	$663	186 (42)	0.9 (0.2)	$40	$4,452	$448
2006	48 (44)	174 (52)	3.9 (1.2)	$107	$3,361	$529	89 (18)	2.3 (0.5)	$92	$4,083	$532
2007	74 (71)	317 (86)	5.9 (1.6)	$275	$4,798	$684	65 (9)	1.1 (0.2)	$24	$2,554	$426
2008	85 (72)	337 (107)	4.1 (1.3)	$195	$5,873	$727	139 (29)	1.9 (0.4)	$70	$3,653	$504
2009	60 (42)	139 (45)	4.1 (1.3)	$234	$5,961	$600	26 (7)	0.9 (0.2)	$127	$11,352	$860

[a] Number of employers in the claim rates analysis and number of employers in the cost analyses in parentheses. There were fewer employers in the cost analyses since employers who participated in programs that reduced the apparent cost of the claims by allowing employers to pay portions of the claims were excluded.

[b] Total number of claims (medical-only and lost-time) and number of lost-time (LT) claims in parentheses.

[c] Total number of claims (medical-only and lost-time) per100 full-time equivalents (FTEs).

[d] Paid 30-month nominal cost.

TABLE II

Regression Results to Estimate Differences Between Affected Employee Workers' Compensation Outcomes Pre- and Post-Intervention, Controlling for Background Time Trend

	Claims per 100 FTE[b]		Cost per FTE[c]		Geometric mean cost per claim[c]	
	Per year[d] RR (95% CI)	Intervention effect[d] RR (95% CI)	Per year[e] RR (95% CI)	Intervention effect[e] RR (95% CI)	Per year[f] RR (95% CI)	Intervention effect[f] RR (95% CI)
All claims	0.89 (0.82, 0.98)*	0.34 (0.19, 0.58)*	0.93 (0.86, 0.99)*	0.19 (0.12, 0.27)*	1.04 (0.98, 1.1)	0.70 (0.56, 0.87)*
Lost time claims	0.86 (0.75, 0.99)*	0.22 (0.12, 0.39)*	0.97 (0.84, 1.09)	0.23 (0.12, 0.42)*	1.16 (1.06, 1.26)*	0.91 (0.63, 1.31)
All claims						
By employer size[a]						
Small	0.91 (0.82, 1.01)	0.20 (0.07, 0.54)*	0.94 (0.84, 1.04)	0.19 (0.08, 0.31)*	1.00 (0.92, 1.09)	0.78 (0.54, 1.12)
Large	0.89 (0.77, 1.02)	0.47 (0.24, 0.92)*	0.93 (0.82, 1.04)	0.22 (0.12, 0.38)*	1.04 (0.97, 1.12)	0.73 (0.56, 0.95)*

[a]Numberof full- and part-time employees, as reported by the employer to the Ohio Department of Job and Family Services for the Quarterly Census of Employment and Wages (QCEW); Small (1–99 employees); Large (≥100 employees).

[b]Total number of claims (medical-only and lost-time) per100 full-time equivalents (FTEs).

[c]Paid 30-month nominal cost.

[d]Poisson regression.

[e]Two-part regression model- refer to Methods and Online Appendix.

[f]Linear regression.

*Significant difference, $P < .05$.

TABLE III

Regression Results to Estimate Industry-Specific Differences Between Workers' Compensation Outcomes Pre- and Post-Intervention

NIOSH industry sector[a]	NAICS codes[b]	Number of employers[c] (%)	Claims per 100 FTE[d], intervention effect[f,i] RR (95% CI)	Cost per FTE[e] intervention effect[g,i] RR (95% CI)	Geometric mean cost per claim[e], intervention effect[h,i] RR (95% CI)
Agriculture, Forestry, Fishing/Hunting	11	3 (0.6%)	0.07 (0.05, 0.11)*	0.15 (NC)[j]	0.94 (0.36, 2.4)
Construction	23	40 (8.5%)	0.58 (0.30, 1.13)	0.3 (0.04, 1.85)	0.77 (0.43, 1.37)
Health care and social assistance	62	60 (12.8%)	0.31 (0.11, 0.87)*	0.32 (0.11, 0.59)*	0.89 (0.66, 1.20)
Manufacturing	31, 32, 33	195 (41.7%)	0.33 (0.20, 0.55)*	0.24 (0.11, 0.53)*	0.72 (0.53, 0.97)*
Mining	21	4 (0.9%)	0.45 (0.40, 0.51)*	0.27 (NC)[j]	1.98 (0.00, 1300.75)
Public safety	92212, 92214, 92216	29 (6.2%)	0.15 (0.05, 0.45)*	0.09 (0.01, 0.51)*	0.57 (0.28, 1.13)
Retail trade	44, 45	16 (3.4%)	0.38 (0.15, 0.99)*	0.32 (0.06, 1.96)	0.85 (0.37, 1.98)
Services (except public safety)	51–56, 61, 71, 72, 81, 92	64 (13.7%)	0.34 (0.17, 0.70)*	0.19 (0.06, 0.65)*	0.57 (0.35, 0.93)*
Transportation, warehousing, utilities	48, 49	14 (3.0%)	0.05 (0.01, 0.29)*	0.56 (0.02, 23.71)	11.21 (1.54, 81.75)
Wholesale trade	42	24 (5.1%)	0.27 (0.09, 0.82)*	0.27 (0.04, 1.67)	0.99 (0.48, 2.03)

[a] As defined by the US National Institute for Occupational Safety and Health (NIOSH).

[b] North American Industry Classification System (NAICS) industry codes of the employers as reported by the Ohio Department of Job and Family Services for the Quarterly Census of Employment and Wages (QCEW). Seventeen (3.6%) employers did not have reported NAICS.

[c] Number of employers in the claim rates analysis and percentage of total employers in parentheses. There were fewer employers in the cost analyses since employers who participated in programs that reduced the apparent cost of the claims by allowing employers to pay portions of the claims were excluded.

[d] Total number of claims (medical-only and lost-time) per100 full-time equivalents (FTEs).

[e] Paid 30-month nominal cost.

[f] Poisson regression.

[g] Two-part regression model-refer to Methods and Online Appendix.

[h] Linear regression.

[i] Model does not control for time trend independent of intervention.

[j] Confidence intervals for the two part model were calculated using a Bootstrap procedure. This procedure is highly unreliable with few observations in a strata, and therefore, strata with fewer than five companies will not have their confidence intervals reported.

Author Manuscript

Author Manuscript

Author Manuscript

* Significant difference, $P < .05$.

TABLE IV

Regression Results to Estimate Differences Between the Workers' Compensation Outcomes Pre- and Post-Intervention by Intervention Major Groups

Intervention major group[a]	Number of employers[b] (%)	Claims per 100 FTE[c], intervention effect[e,h] RR (95% CI)	Cost per FTE[d], intervention effect[f,h] RR (95% CI)	Geometric mean cost per claim[d], intervention effect[g,h] RR (95% CI)
Ergonomic	348 (74%)	0.31 (0.20, 0.48)*	0.17 (0.00, 0.29)*	0.73 (0.59, 0.91)*
Safety	38 (8%)	0.09 (0.02, 0.50)*	0.11 (0.10, 0.13)*	0.78 (0.44, 1.37)
Ventilation	8 (2%)	2.19 (0.86, 5.60)	3.53 (1.65, 5.16)*	2.64 (1.15, 6.08)*
Multiple-purpose	69 (15%)	0.24 (0.12, 0.49)*	0.12 (0.08, 0.15)*	0.52 (0.3, 0.88)*

[a]Intervention type determined by consensus rating of two certified professional ergonomists based on case study reviews.

[b]Number of employers in the claim rates analysis and percentage of total employers in parentheses. There were fewer employers in the cost analyses since employers who participated in programs that reduced the apparent cost of the claims by allowing employers to pay portions of the claims were excluded.

[c]Total number of claims (medical-only and lost-time) per100 full-time equivalents (FTEs).

[d]Paid 30-month nominal cost.

[e]Poisson regression.

[f]Two-part regression model- refer to Methods and Online Appendix.

[g]Linear regression.

[h]Model does not control for time trend independent of intervention.

*Significant difference, $P < .05$.

TABLE V

Post-hoc Analysis Results Dividing Affected Employee Workers' Compensation Claim Frequency Into (a) Yearly and (b) Quarterly Rates[a]

	Study period	Claim rate[a] RR[c] (95% CI)	Cost per FTE[b] RR[d] (95% CI)	Geometric mean cost per claim[b] RR[e] (95% CI)
a.				
Pre-Intervention	2nd year	1.03 (0.89, 1.20)	0.96 (0.7, 1.32)	1.01 (0.85, 1.21)
Post-Intervention	3rd year	0.50 (0.32, 0.79)*	0.28 (0.16, 0.5)*	0.67 (0.51, 0.88)*
	4th year	0.31 (0.14, 0.66)*	0.15 (0.07, 0.34)*	0.79 (0.56, 1.1)
b.				
Pre-Intervention	2nd year	1.03 (0.89, 1.20)	0.96 (0.7, 1.32)	1.01 (0.85, 1.21)
Post-Intervention	3rd year, 1st quarter	0.62 (0.41, 0.91)*	0.26 (0.14, 0.47)*	0.67 (0.46, 0.97)*
	3rd year, 2nd quarter	0.52 (0.28,0.96)*	0.28 (0.1, 0.76)*	0.71 (0.48, 1.03)
	3rd year, 3rd quarter	0.52 (0.33, 0.82)*	0.42 (0.16, 1.06)	0.60 (0.39, 0.94)*
	3rd year, 4th quarter	0.39 (0.20, 0.78)*	0.22 (0.09, 0.52)*	0.68 (0.46, 1.02)
	4th year, 1st quarter	0.51 (0.24, 1.07)	0.33 (0.13, 0.84)*	0.86 (0.56, 1.32)
	4th year, 2nd quarter	0.29 (0.15, 0.58)*	0.12 (0.05, 0.34)*	0.65 (0.39, 1.07)
	4th year, 3rd quarter	0.21 (0.08, 0.54)*	0.07 (0.02, 0.22)*	0.67 (0.38, 1.17)
	4th year, 4th quarter	0.26 (0.10, 0.70)*	0.14 (0.05, 0.39)*	0.92 (0.56, 1.53)

Note: All regression models control for time trend. Rate ratios are in reference to the first year of the pre-intervention data.

[a]Total number of claims (medical-only and lost-time) per 100 full-time equivalents (FTEs).

[b]Paid 30-month nominal cost.

[c]Poisson regression.

[d]Two-part regression model- refer to Methods and Online Appendix.

[e]Linear regression.

*Significant difference, $P < .05$.

TABLE VI

Post-hoc Regression Results Comparing the Unaffected Employee Workers' Compensation Claim Frequency Rates[a] Pre- and Post-Intervention, Controlling for Time Trend

Claim type	Employer count	Per year[c] RR (95% CI)	Intervention effect[c] RR (95% CI)
All claims	446	0.86 (0.78, 0.95)*	1.06 (0.88, 1.29)
All claims			
By Employer size[b]			
Small	242	0.95 (0.89, 1.01)	0.89 (0.7, 1.14)
Large	204	0.85 (0.76, 0.94)*	1.10 (0.88, 1.39)

[a]Total number of claims (medical-only and lost-time) per 100 full-time equivalents (FTEs).

[b]Number of full- and part-time employees, as reported by the employer to the Ohio Department of Job and Family Services for the Quarterly Census of Employment and Wages (QCEW); Small (1–99 employees); Large (≥100 employees).

[c]Poisson regression.

*Significant difference, $P < .05$.