Effect of State Workplace Safety Laws on Occupational Injury Rates

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The purpose of this study was to evaluate the effect of four common types of mandatory state-level workplace safety regulations on injury severity rates during the period 1992 to 1997 for the manufacturing sector. The full Poisson regression model showed safety committee regulations to have a highly significant reducing effect on injury rates, χ^2 (1, n = 3286) = 10.1774, P = 0.0014. Safety program regulations were significant at the $\alpha = 0.10$ level, χ^2 (1, n = 3286) = 3.5676, P = 0.0589. The effect of insurance carrier loss control regulations in the full model was nonsignificant. However, insurance carrier loss control regulations were highly significant ($\alpha = 0.01$) in the final reduced model. Targeting initiatives were nonsignificant in both the full and reduced models ($\alpha = 0.05$). The study results are important to state and federal agencies considering adopting workplace safety regulations that are similar to the four types evaluated in this study. (J Occup Environ Med. *2001;43:1001–1010*)

Workers' compensation (WC) costs began a dramatic increase in the 1980s. By the early 1990s, some states began to respond to runaway WC costs by overhauling WC programs and embracing various types of workplace safety initiatives. WC costs declined each year between 1992 and 1996.[1,2] The National Academy of Social Insurance (1999) attributed the recent decline in WC costs to three identifiable trends: fewer workplace injuries, improvements in WC programs, and a reduction in the generosity of WC programs.

State governments in the late 1980s and early 1990s promulgated a wave of workplace safety initiatives and WC system reforms. The state workplace safety initiatives differ from federal Occupational Safety and Health Administration (OSHA) standards and can be classified into five specific categories: (1) mandatory employer health and safety program requirements (ie, requirements for certain employers to implement written accident prevention programs); (2) mandatory employee safety committee requirements (ie, certain employers required to have employee health and safety committees; (3) targeted enforcement initiatives directed toward high-accident or high WC claim frequency employers, either through an approved state OSHA department or through the state's WC administrative agency (sometimes known as "extra-hazardous" employer programs, in which certain employers are listed and targeted by the state); (4) state regulation of WC insurance carrier accident prevention services (sometimes

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known as "loss control" regulations, requiring WC insurance carriers to assist employers with implementing health and safety programs); and (5) voluntary workplace safety initiatives.

Voluntary programs range in scope from offering employers premium discounts for maintaining drugfree-workplace programs to providing state-sponsored employee and employer safety training initiatives. Although voluntary programs are potentially important in the recent decline of occupational injury rates, additional research is needed on the most common types of mandatory safety requirements found on the state level.

Conway and Svenson[3] compared occupational injury rates between states with mandatory occupational safety and health program requirements and states with voluntary programs. The study found no significant difference between injury rates or injury rate declines for states with mandatory safety and health program requirements versus states without mandatory requirements.

Most of the state workplace safety interventions were initiated to reduce occupational injury rates and the associated WC costs. Although Conway and Svenson identified the state-level safety interventions as a plausible cause for the recent national decline in occupational injury and illness rates, the state workplace safety initiatives have not been comprehensively evaluated. The purpose of this analysis was to evaluate the effect of the four types of mandatory state workplace safety interventions on occupational injury rates during the period 1992 to 1997. The study results are important to state and federal agencies considering adopting workplace safety regulations that are similar to the four types evaluated in this study.

The current study seeks to improve on the Conway and Svenson analysis by incorporating various economic, regulatory, and demographic covariates in the explanatory model. Consideration of these additional covariates is important because state-to-state differences can be problematic when comparing occupational injury rates. A proposed explanatory model for the injury rate decline during the period 1992 to 1997 is shown in Fig. 1.

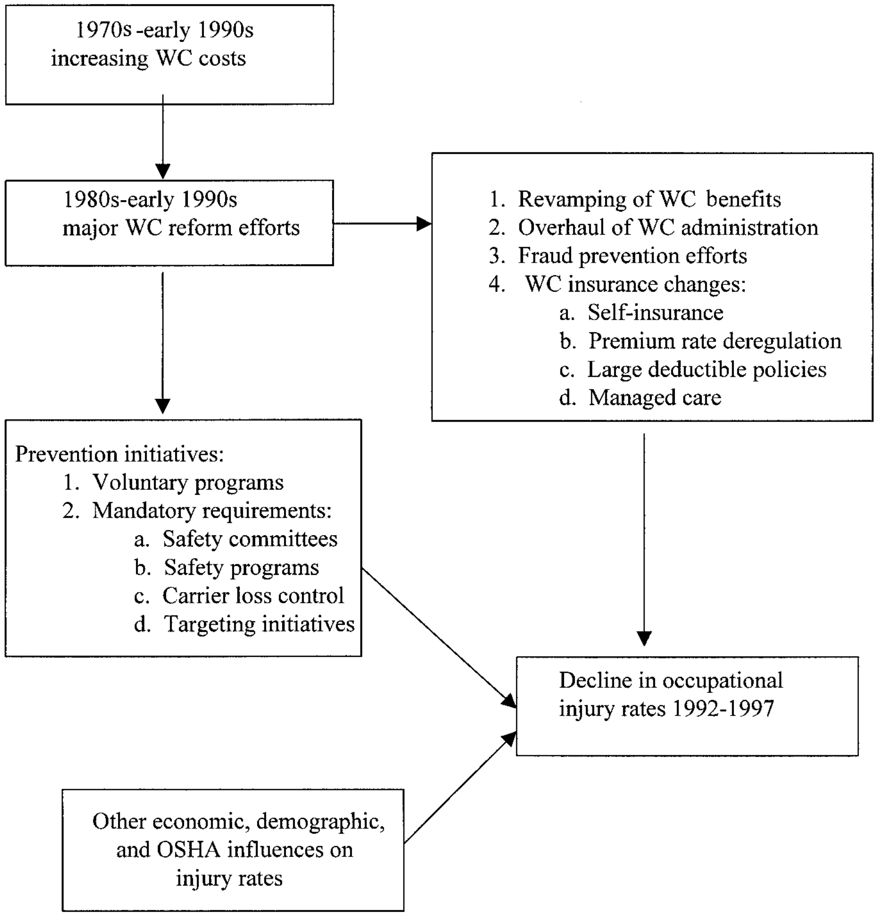

Fig. 1. Proposed explanatory model (injury rate decline, 1992 to 1997). WC, workers' compensation.

Workplace injury rates are thought to be a function of labor-force size, unemployment rates, age of the workforce, employment-type distribution, and government involvement in the labor market.[4] A cyclical aspect of occupational injury rates is evident in that rates have tended to increase during periods of economic downturns and decrease during periods of growth.[3] This may be related to changes in the pace of work (eg, orders piling up) or to the influx of new, inexperienced workers when hiring increases.

Furthermore, the level of workplace safety in the United States is inherently linked to two public policy forces: (1) state WC insurance, and (2) OSHA.[5] Other economic and demographic factors are also suspected as causative factors. The importance of considering WC as a causative factor in occupational injury rates has been demonstrated by Bartel and Thomas,[6] Butler,[7] Butler and Worral,[8] Chelius,[9,10] and Worrall and Appel,[11] all of whom found positive relationships between WC benefits and injury rates in their samples.[12] OSHA influences on injury rates are also an important factor, as demonstrated by Curington,[13] Gray and Scholz,[14] and Cooke and Gautschi.[15] Ohsfeldt and Morrisey[16] included both WC and OSHA variables in their study of industrial injury rates and state beer taxes.

Methods

A panel of data organized by state and year (1992 to 1997) was used in the statistical analysis. The effect of the four types of mandatory state safety initiatives on occupational injury severity rates was evaluated at the 2-digit standard industrial classification (SIC) manufacturing level. Poisson regression was used to analyze the data. The injury severity case rate included total lost workday cases involving days away from work, or days of restricted work activity, or both. The severity case rate did not include fatal injuries. The data set consisted of 3286 observations, with 21 variables derived for 42 states. The cohort of states changed slightly from year to year, depending on the availability of state-level injury severity rates.

State-to-state comparisons of safety performance outcome measures may be problematic because of differences in economic and demographic makeup. Ohsfeldt and Morrisey[16] considered various economic and demographic variables in their study of the relationship between state beer taxes and industrial injury rates. Similar covariates are used in the current study, as detailed in Table 1.

Ohsfeldt and Morrisey used the following three variables to represent WC rules: (1) maximum weekly payment under the state's WC law divided by the average wage in the industry, (2) the ratio of the minimum weekly payment to average weekly wages in the industry, and (3) the WC benefit waiting period in days. The two ratios can be used to describe the value of an injury to a worker. As either ratio increases, the value of an injury to a worker increases. The benefit-waiting period was expected to correlate with injury rates; ie, a shorter waiting period would give a greater incentive to report injuries and pursue WC claims.

Labor force characteristics can be represented by educational attainment (percentage of college graduates in the state), the proportion of female employment in the industry, the age-cohort size of the state labor force, and the unemployment rate.[16] Greater educational attainment may be associated with a more knowledgeable (hence, safer) workforce and with better knowledge of WC rules and benefits. With advancing age, knowledge of safe work practices may increase but physical aptitude may decrease, leaving an older worker more susceptible to injury. Female employees may be concentrated in less hazardous occupations within industry groups.[16] The unemployment rate is intended to capture business cycle effects.[9]

The firm-characteristic variable used by Ohsfeldt and Morrisey is the mean number of employees per firm in an industry category, the notion being that larger firms may be able to apply economy of scale in workplace safety enhancement. The firm-characteristic variable can also be useful for capturing the likelihood that larger-sized firms may be more fully experience-rated, thus benefiting from stronger safety incentives.[17]

Some of the state-level injury covariates identified by Ohsfeldt and Morrisey were used in the current study to account for the effects of economic and demographic influences. Because only the manufacturing sector was of interest in the analysis, educational attainment was represented by the percentage of high school graduates in the state instead of the percentage of college graduates. WC effects were represented by the maximum benefit ratio (some states have no minimum WC payment) and the WC benefit waiting period. Female participation rates were excluded from the analysis because this variable cannot be quantified at the 2-digit manufacturing SIC level.

Because OSHA inspections, fines, and worksite safety consultations may play a role in injury severity rates, these variables were also included in the analysis. Possible differences in injury severity rates because of the activity of state OSHA programs (versus states operating under federal OSHA jurisdiction) were accounted for in the analysis by including appropriate classification variables.

The percentage of the state's manufacturing workforce that was unionized was included in the analysis. Unions actively pursue their objective of safer workplaces through lobbying or bargaining efforts. Union contract clauses requiring labor-management safety committees have increased over the past 20 years.[3]

States with a higher proportion of unionized workers may be more likely to have lower occupational injury rates. Unions are known to be vocal about health and safety conditions, and they often cooperate with corporations to identify and eliminate workplace hazards.[3] On the other hand, unionized workers may be more likely to file WC claims. This could be a result of unionized workers having less fear of employer retaliation for filing WC claims or because of a higher proportion of hazardous industries having unionized workforces.[18] The percentage of the state's manufacturing workforce that is unionized was included as a covariate in the regression modeling.

The variables can be divided into the following four major effect groups: (1) safety, (2) OSHA, (3) economic, and (4) demographic. Data were available on three primary levels (state, manufacturing, and 2-digit manufacturing SIC). It was expected that the main difference in injury rates across states would be attributable to industry differences apparent at the 2-digit manufacturing SIC level rather than to state-to-state differences.

A comprehensive review and rating of each state according to its inclusion of the four workplace safety initiatives was completed. The relative regulatory strength of safety program and safety committee requirements was rated by recording the percentage of the workforce within the industry affected by the

TABLE 1
Independent Predictor Variables*

Variable	Level	Group	Variable Definition
Safety committee	2-digit SIC, manufacturing	Safety	Percentage of workforce affected by mandatory safety committee requirements†
Safety program	2-digit SIC, manufacturing	Safety	Percentage of workforce affected by requirements for mandatory implementation of employer health and safety programs†
Loss control	2-digit SIC, manufacturing	Safety	Workforce affected by mandatory insurance carrier accident prevention service requirements?†
Targeting	2-digit SIC, manufacturing	Safety	Workforce affected by targeted or "extra hazardous" employer laws?†
State OSHA plan	State	OSHA	State OSHA Plan state?†
OSHA inspections	2-digit SIC, manufacturing	OSHA	No. of inspections per year, manufacturing only (normalized to per 1000 workers)‡
OSHA visits	2-digit SIC, manufacturing	OSHA	State safety consultation site visits/contacts, manufacturing only (normalized to per 1000 workers)‡
OSHA fines	2-digit SIC, manufacturing	OSHA	Dollar amount of fines per manufacturing workers‡
Employer size	2-digit SIC, manufacturing	Economic	Industry firm average size§
Union membership	Manufacturing	Demographic	Percentage of workforce unionized‖
Unemployment	State	Economic	State unemployment (%)‖
WC maximum payment	Manufacturing	Economic	WC maximum payment index¶
WC waiting period	2-digit SIC, manufacturing	Economic	WC waiting period¶
High school graduation rate	State	Demographic	State high school graduates (%)‖
Age 25–34	State	Demographic	State employment, age 25–34 (%)**
Age 35–44	State	Demographic	State employment, age 35–44 (%)**
Age 45–54	State	Demographic	State employment, age 45–54 (%)**
Age 55–64	State	Demographic	State employment, age 55–64 (%)**

* SIC, standard industrial classification; OSHA, Occupational Safety and Health Administration; WC, worker's compensation.
† Data obtained by contacting state agencies, reviewing state Web sites and regulations, and reviewing available literature. Year the requirement became effective is used in the analysis.
‡ OSHA inspection, fines, and voluntary consultations obtained from Reference 19. Employment by 2-digit SIC obtained from Reference 20. If employment by 2-digit SIC was missing for a specific year, then the most recent year of available data was used in the calculation.
§ Average firm size derived from Reference 21. Employment by 2-digit SIC obtained from Reference 20. Because data are available for 1992 only for firm average size, the 1992 result was repeated for the years 1993–1997.
‖ Data from Reference 22. In some cases, the variables were derived from available data. Percent workforce unionized for years 1992 and 1993 from unpublished data (provided by David Macpherson, Florida State University). Data for educational attainment were from 1990 information (repeated for each year, 1992 to 1997).
¶ WC maximum payment = weekly maximum WC payment ÷ average manufacturing weekly wage. WC benefits by state available from Reference 23. Average weekly wages derived from information contained in Reference 23.
** Derived from Reference 25.

specific requirements. This was determined by identifying the statutory coverage of the specific regulations and then calculating the workforce coverage based on the employment size distribution within each specific 2-digit manufacturing SIC classification. Calculation of the percentage of the workforce affected by employer targeting programs and insurance carrier accident prevention regulations was problematic because of the sparseness of available data; thus, such programs were recorded as dichotomous variables only (yes or no) for specific years.

A major limitation of this study was the stratification of data on variables across three levels (state, manufacturing, and 2-digit SIC manufacturing). Ideally, all of the variables should be derived from the 2-digit SIC manufacturing level because that is the level at which the outcome variable is derived. Some data were not available at the manufacturing level (ie, the demographic variables).

Another possible source of bias in the analysis is the reasoning behind changes in state WC and safety law. If the states that implemented mandatory safety program requirements did so in response to high injury rates

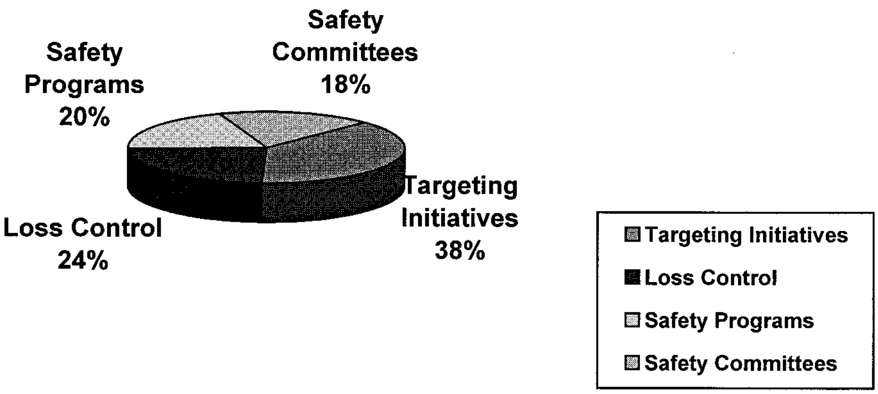

Fig. 2. Distribution of safety requirements by type across 42 states (1992 to 1997).

(as compared with states not implementing such measures), then the regression modeling may not fully capture the effect of these initiatives (ie, the safety initiatives may be positively correlated with injury rates). Conway and Svenson[3] found that states with mandatory safety and health program requirements had higher average injury rates than did states without such requirements.

Results

Figure 2 shows the breakdown of mandatory requirements by type for 42 states during the period 1992 through 1997. The first Poisson regression model in the analysis contained all of the variables from Table 1.[19–23] Table 2 displays the parameter estimates for that analysis. As expected, a main effects model (2-digit SIC) was demonstrated. The 2-digit SIC component had the highest chi-squared value (4673.2220), which was highly significant at the $\alpha = 0.01$ level ($P = 0.0001$). The *year* variable was significant at the $\alpha = 0.01$ level. The decreasing parameter estimates for the *year* variable paralleled the actual injury rate decreases that occurred each year from 1992 through 1997.

Effect of State Safety Requirements

The full Poisson regression model showed that the *safety committee* variable had a highly significant reducing effect on injury rates, χ^2 (1, $n = 3286$) = 10.1774, $P = 0.0014$. The *safety program* variable was significant at the $\alpha = 0.10$ level, with a negative parameter estimate, χ^2 (1, $n = 3286$) = 3.5676, $P = 0.0589$. Although the *loss control* variable had a negative parameter estimate, suggestive of an injury-reducing capability, the effect in the full model was nonsignificant, χ^2 (1, $n = 3286$) = 0.8025, $P = 0.3703$. This was probably because it was associated with other predictor variables. However, the *loss control* variable was highly significant at the $\alpha = 0.01$ level in the final reduced model. The parameter estimate for the *targeting* variable was positive and nonsignificant in both the full and reduced models.

Effect of OSHA, Economic, and Demographic Variables

The variable accounting for state and federal OSHA inspections was significant at the $\alpha = 0.01$ level, χ^2 (1, $n = 3286$) = 55.3465, $P = 0.0001$. However, the parameter estimate for the *OSHA inspection* variable was positive. Although not as significant, ($P = 0.0486$), the same was true for the variable representing state OSHA consultations. The variable representing OSHA monetary fines levied by 2-digit SIC was not significant, χ^2 (1, $n = 3286$) = 0.1676, $P = 0.6823$ and, again, the parameter estimate was positive.

The analysis of the *OSHA inspection*, *consultation*, and *fines* variables in the model yielded positive parameter estimates. However, it was expected that these variables would have a negative correlation with the injury rates. The results for the inspection and consultation variables make more sense when OSHA's 1990s trend of targeting employers with above-average injury rates for inspection is taken into account. Consultations may be positively correlated because it is expected that employers with higher injury rates will seek voluntary assistance. The positive correlation of fines with injury rates suggests that employers with high injury rates in certain 2-digit SIC classifications may have been receiving higher monetary penalties.

The *state OSHA plan* variable is a classification variable that distinguished those states under federal OSHA jurisdiction from states that operated their own approved OSHA plan. This variable was nonsignificant, χ^2 (1, $n = 3286$) = 0.0755, $P = 0.7835$. The results suggest that the effectiveness of state OSHA plans has been on par with federal OSHA plans during the period 1992 through 1997.

The *employer size* variable represents the average level of employment within each 2-digit SIC (number of firms/total number employed in the SIC). This variable was highly significant at the $\alpha = 0.01$ level, χ^2 (1, $n = 3286$) = 25.4835, $P = 0.0001$ with a negative parameter estimate. Because larger firms have more resources for workplace safety programs, it is logical to expect them to have lower occupational injury rates. Small employers may experience above-average occupational injury rates because often they lack the resources to implement effective safety and health programs. The negative parameter estimate suggests an inverse relationship between the average firm size within each SIC and the occupational injury severity rate.

The WC waiting period and WC maximum payment variables represented the WC effects. The *WC wait-*

TABLE 2

Analysis of Parameter Estimates (Original Full Model)*

Variable	Estimate	χ^2	SE	$P > \chi^2$
Year†‡	–	88.6481	–	0.0001
SIC‡§	–	4673.2220	–	0.0001
Safety committee‡	−0.0782	10.1774	0.0245	0.0014
Loss control	−0.0160	1.0380	0.0157	0.3083
Safety program‖	−0.0416	3.5676	0.0220	0.0589
Targeting	0.0138	0.8025	0.0154	0.3703
OSHA inspections‡	0.0275	55.3465	0.0037	0.0001
OSHA fines	0.0002	0.1676	0.0004	0.6823
OSHA visits¶	0.0104	3.8893	0.0053	0.0486
Employer size‡	−0.0005	25.4835	0.0001	0.0001
State OSHA plan	0.0038	0.0755	0.0138	0.7835
WC maximum payment‡	−0.1233	18.4132	0.0287	0.0001
WC waiting period‡	−0.0220	39.0155	0.0035	0.0001
High school graduation rate	−0.0604	0.0622	0.2422	0.8031
Age 25–34‡	−2.5854	9.0136	0.8612	0.0027
Age 35–44	−1.4081	1.9584	1.0062	0.1617
Age 45–54‡	−0.1767	11.2803	0.0526	0.0008
Age 55–64	−0.4256	0.1952	0.9633	0.6586
Union membership‡	0.8629	92.8689	0.0895	0.0001
Unemployment‡	−3.4353	29.5802	0.6316	0.0001

* SE, standard error; SIC, standard industrial classification; OSHA, Occupational Safety and Health Administration; WC, worker's compensation.

† To save space, parameter estimates are not shown for the *Year* variable because it has six levels.

‡ Significant at the $\alpha = 0.01$ level.

§ To save space, parameter estimates are not shown for the *SIC* variable because it has 20 levels.

‖ Significant at the $\alpha = 0.10$ level.

¶ Significant at the $\alpha = 0.05$ level.

ing period variable is the waiting period (by state) for receiving WC benefits. This variable was highly significant at the $\alpha = 0.01$ level, χ^2 (1, n = 3286) = 39.0155, P = 0.0001, with a negative parameter estimate. The literature strongly supports the relationship between the WC indemnity waiting period and workplace injury rates. A longer waiting time correlates with lower occupational injury rates, which indicates that the incentive to report an injury may be reduced if the waiting period for WC benefits is long. Conversely, a shorter waiting period may increase the likelihood that injuries are reported so that benefits may be obtained. Most states have WC benefit waiting periods ranging from 3 to 7 days.[24] If a worker were unable to work because of an on-the-job injury filed under WC, no wage replacement benefits would be available until the waiting period ended. The inverse effect of the WC waiting period on injury severity rates found in the analysis was consistent with the literature.

The *WC maximum payment* variable represents the maximum payment available under WC divided by the average weekly manufacturing wage in each state. This variable, used to measure the incentive effects of WC, was significant at the α = 0.01 level, χ^2 (1, n = 3286) = 18.4132, P = 0.0001, with a negative parameter estimate.

Ohsfeldt and Morrisey[16] contended that as the weekly WC payment and average weekly industry wage ratio increase, the incentive to report WC claims increases. In this analysis the opposite effect was observed, suggesting that a higher weekly benefit resulted in a lower rate of occupational injury in the state. Ohsfeldt and Morrisey discussed the potential ambiguous nature of the *WC maximum payment* variable. As it increases, the incentive to report WC injuries may also increase. However, this effect may be offset by other factors. For example, states with better WC benefits may also be more aggressive in the areas of fraud prevention and workplace safety.

The age classification representing the percentage of the state's population in the age range of 25 to 34 years was significant at the $\alpha = 0.01$ level, χ^2 (1, n = 3286) = 9.0136, P = 0.0027, with a negative parameter estimate. The second and fourth age classification variables (ages 35 to 44 years, and 55 to 64 years) were nonsignificant at the $\alpha = 0.10$. The third age classification variable (45 to 54 years old), like the first, was highly significant at the $\alpha = 0.01$ (P = 0.0008), with a negative parameter estimate.

The variables representing state population age characteristics were somewhat ambiguous. This was not surprising, because age is expected to have an ambiguous effect on injury rates. An older workforce has more experience and may demonstrate fewer risk-taking behaviors, with a resultant reduction in incidence and severity of workplace injuries. At the same time, an older workforce may incur more injuries than a younger workforce because of a decline in their physical capabilities. On the other hand, a younger workforce, although less experienced, is more physically agile and, perhaps, will experience fewer musculoskeletal injuries. A younger workforce may have higher rates of workplace injury because they may be more prone to engage in risk-taking behaviors.

The results of the analysis suggest that states with a higher proportion of younger workers (range, 25 to 34 years of age) may be experiencing fewer work-related injuries. The third age classification variable represented the percentage of the state's population in the 45- to 54-year age range. This variable, like the first, was highly significant, with a negative parameter estimate (reducing effect). The third age classification variable, 45 to 54 years of age, may well represent the "ideal" workforce age range, in that their physical capabilities have not deteriorated, they are less prone to risk-taking behaviors, and their work experience is mature.

The *HS graduation rate* variable represented the percentage of high school graduates in the state. Although the parameter estimate was negative, the contribution of this variable to the model was not significant at the $\alpha = 0.10$ level, χ^2 (1, n = 3286) = 0.0622, P = 0.8031. As expected, the parameter estimate for the variable representing the percentage of high school graduates was negative. The negative estimate suggests an inverse relationship between education and injury, with a better-educated workforce experiencing fewer injuries. However, the contribution of this variable to the model was not significant.

The *union membership* variable represented the percentage of the state's manufacturing workforce under union membership. Unions were expected to have a reducing effect (negative parameter estimate) on injury rates in the model. However, the *union membership* variable was highly significant at the $\alpha = 0.01$ level, χ^2 (1, n = 3286) = 92.8689, P = 0.0001, with a positive parameter estimate. The positive effect suggests a correlation between union presence and high injury rates (ie, certain manufacturing 2-digit SIC classifications). Unionized workforces may be more likely to be found in high-hazard industries. The union effect in the model was very important (χ^2 = 92.8689). In terms of the size of the χ^2 values, the union effect was second only to the large SIC effect.

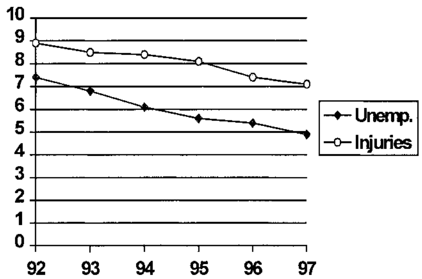

Fig. 3. National unemployment rate versus occupational injury and illness rate.[25]

The *unemployment* variable is the unemployment rate within each state for the years 1992 through 1997. During that time, the effect of unemployment rates on occupational injury severity rates was highly significant at the $\alpha = 0.01$ level, χ^2 (1, n = 3286) = 29.5802, P = 0.0001, with a negative parameter estimate. This result suggests that the effect of unemployment on injury rates was inverse at the state level (as unemployment goes down, injury rates go up, or vice versa). Figure 3 shows the relationship between the national unemployment rate and occupational injury and illness frequency rate from 1992 to 1997.

The Poisson regression results suggest that the effect of unemployment at the state level is different from the national trend demonstrated in Fig. 3. The overall decline in national work-related injury rates seems to be directly related to the decline in the unemployment rate. As shown by the regression analysis, the relationship between unemployment rates and occupational injury rates on the state level is significant and in the inverse direction. This suggests that in states where unemployment rates were higher from 1992 through 1997, the work-related injury severity rates were actually lower. This could have resulted from shrinkage in the employed workforce. A reduction in workforce reduces the denominator (total work hours of exposure) of the injury-severity rate calculation. This effect might also be explained by slowdowns in production rates in states where unemployment is higher or economic conditions are worse. Another possible explanation is that when the labor market gets tighter (ie, unemployment rates are low), less experienced or less capable workers may enter the labor market. This influx of new, inexperienced workers may increase occupational injury rates.

Chelius[9] described the unemployment rate as a measure of the impact of the business cycle on occupational injury rates. He reasoned that an increase in unemployment would lower the effectiveness of prevention efforts by making workers more susceptible to injuries, in that more work would be expected of fewer workers. Furthermore, lower unemployment rates associated with an upswing in production would make it more difficult to replace an injured worker, which would increase the cost of injuries to employers, thus making prevention more economical. Chelius concluded that this combination of conflicting outcomes leads to uncertain predictions about the impact of the unemployment rate on occupational injury rates. The uncertainty of the degree to which the unemployment rate captures the effects of the business cycle may be a limitation in the interpretation of the results.

TABLE 3
Final Reduced Model*

Variable	Estimate	χ^2	SE	$P > \chi^2$
Year†	–	140.2687	–	0.0001
SIC‡	–	4929.7449	–	0.0001
Safety committee	−0.1365	16.9651	0.0331	0.0001
Loss control	−0.0544	10.9918	0.0164	0.0009
Safety program	−0.1270	16.4140	0.0314	0.0001
Targeting	0.0195	1.3854	0.0166	0.2392
Safety Committee–loss control§	0.1314	7.7711	0.0472	0.0053
Safety Committee–targeting§	−0.1507	11.6444	0.0442	0.0006
Safety Program–loss control§	0.0998	9.7388	0.0320	0.0018
OSHA inspections	0.0290	79.3939	0.0033	0.0001
Employer size	−0.0006	32.4354	0.0001	0.0001
WC maximum payment	−0.1356	25.2006	0.0270	0.0001
WC waiting period	−0.0232	44.4218	0.0035	0.0001
Age 25–34	−2.7618	18.9768	0.6340	0.0001
Age 45–54	−0.1759	11.7705	0.0513	0.0006
Union membership	0.8218	122.4798	0.0743	0.0001
Unemployment	−2.6819	27.0568	0.5156	0.0001

* Although nonsignificant, the targeting variable was kept in the reduced model because it was in one of the interaction terms. For definition of abbreviations, see Table 2.
† To save space, the parameter estimates are not shown for the *Year* variable because it has six levels.
‡ To save space, the parameter estimates are not shown for the *SIC* variable because it has 20 levels.
§ Two-way interaction terms.

Reduced Model

Removal of nonsignificant terms (the reduced model parameter estimates are shown in Table 3) reduced the model. The OSHA variables removed from the model include *OSHA fines* (representing OSHA penalties), *OSHA visits* (representing OSHA voluntary consultations), and *state OSHA plan* (representing OSHA plan states) variables. None of the economic variables was removed from the model. Demographic variables removed from the model included the *HS graduation rate* variable (representing the percentage of high school graduates) and the *age 35 to 44* and *age 55 to 64* variables (representing the percentage of population 35 to 44 years old and 55 to 64 years old, respectively).

The reduced model demonstrated that the *safety committee*, *safety program*, and *loss control* variables were highly significant at the $\alpha = 0.01$ level with negative parameter estimates (suggestive of a reducing effect on injury rates). Various 2-way safety variable interaction terms were evaluated in separate models. In the final reduced model, the combination of safety committee laws and targeting initiatives, χ^2 (1, $n = 3286$) = 11.6444, $P = 0.0006$, were found to be the most important.

Adoption of Safety Requirements

Of the 24 states that implemented workplace safety requirements from 1990 through 1997, 16 (67%) had occupational injury and illness frequency rates exceeding the national average. This finding suggests an endogenous relationship between the state–level occupational injury and illness rate and the adoption of additional workplace safety regulations (ie, high rates led states to adopt the workplace safety requirements).

An endogenous relationship between the occupational injury rate variable and the safety variables could dampen the effect of the regulations in the Poisson model. However, because the occupational injury rate used in the analysis was at the 2-digit SIC manufacturing level, the endogenous relationship may have been less pronounced; that is, it would have been less likely that an above-average injury rate in any particular manufacturing SIC(s) contributed to the adoption of safety requirements.

To further evaluate this supposition, occupational injury rates within the manufacturing SICs were compared with the national average (for each SIC) for six states that implemented workplace safety regulations in 1993. Injury severity rates for 1992 were used to compare pre-regulation rates for the year before the adoption of the requirements. Five of the six states had above-average overall occupational injury and illness frequency rates as compared with the national average for the year before their adoption of additional workplace safety regulations. Fifty-three percent of the 2-digit manufacturing SICs within the six states had below-average injury severity rates. As expected, this qualitative comparison demonstrated how the endogenous relationship between the outcome variable and the state safety regulations is less apparent at the 2-digit SIC manufacturing level than at the overall state level.

Conclusions

The Poisson regression modeling suggests that the safety committee, safety program, and insurance carrier loss control regulations initiated at the state level had a significant impact in the reduction of occupational injury severity rates during the period 1992 through 1997. Because these regulations often occur together in the same state, the interaction of the four approaches is also potentially important, as demonstrated in the reduced model.

Of the four types of safety requirements found at the state level, safety committee regulations and safety program regulations had the most injury-reducing potential. The *safety committee* variable had the highest chi-squared value compared with the other safety variables, which may have resulted from its inherent action orientation.

Safety committee laws require certain employers to establish workplace safety committees comprised of labor and management representatives. These committees are required to meet at certain intervals to discuss health and safety issues. The safety committees allow employees to voice concerns about safety and health and to make suggestions concerning methods to improve workplace safety. The safety committee requirement is an action-oriented and communication-centered approach, perhaps more so than the other three safety variables.

The *safety program* variable was significant in the model but with a lower chi-squared value than the safety committee requirement. Generally, there are only slight variations in the scope of this type of legislation among the states that have safety program requirements. Most states incorporate requirements for certain employers to have a written health and safety management plan that addresses management commitment, hazard identification and control, and employee involvement. The intent is to encourage employers to design effective health and safety programs that address site-specific needs. Although this approach is action-oriented in that it requires a written health and safety program, the effect on injury rates may be lost if the employer maintains the written program for compliance purposes but fails to enact the program plan for improving safety.

The variable representing insurance carrier loss control requirements was nonsignificant in the original full model but highly significant in the reduced model. Loss control regulations are aimed at insurance companies that sell WC insurance. Laws often require WC insurance carriers to develop strategies to help employers reduce losses and improve safety. These requirements may regulate the scope and frequency of accident prevention services provided by insurance companies or they may mandate that carriers help employers develop health and safety programs. This mode of regulation might best be described as indirect, because the focus is on the insurance carrier instead of the employer.

The indirect nature of insurance carrier regulations may contribute to the effect of loss control regulations in the model, because the chi-squared value was lower for insurance carrier regulations than for the safety committee and safety program variables. Most WC insurance carriers have a vested interest in helping employers reduce losses and improve safety, because such efforts increase their profits. This form of regulation may be unnecessary because of the strong economic incentive for WC insurance carriers to voluntarily engage in safety and prevention efforts.

The variable representing targeting initiatives was nonsignificant in both the full and reduced models, with a positive parameter estimate, suggestive of an increasing effect on injury rates. This result may be somewhat ambiguous. Targeting initiatives involve those state-level regulations that require certain employers with high WC loss rates or above-average injury rates to implement safety requirements. These requirements often include the mandatory implementation of comprehensive safety and health programs. In some cases, safety committees are required as part of the targeting initiatives. Some states require high-loss and high-injury rate employers to undergo mandatory safety evaluations or consultations from state or insurance carrier safety professionals.

The targeting approach was found to be the most popular among all state-level safety requirements. However, the very nature of targeting programs suggests that, at least initially, the correlation would be positive between targeting programs and high injury rates. This was found to be true in the model. Targeting initiatives involve safety requirements for employers with above-average injury or WC loss rates. Targeting strategies seek to reduce the injury rates of the upper range of outliers from the population of workplaces; therefore these initiatives might not have been in effect long enough to significantly reduce injury rates.

Implications

The significant impact of safety committee laws, safety program regulations, and loss control regulations on occupational injury severity rates is important. The effectiveness of state regulation of workplace safety deserves adequate evaluation. Ineffective regulations can be burdensome to business and to the economy.

A cost-benefit analysis is an important component of governmental regulatory action. This study provides useful information concerning the benefit of safety committee, safety program, and insurance carrier loss control regulations in reducing occupational injuries. This information is important for states considering implementation of additional workplace safety regulations, either through their WC agency or through an approved state OSHA plan. The information is also important to federal OSHA as new standards and new workplace safety initiative are considered.

State workplace safety committee laws, safety program laws, and insurance carrier loss control regulations, outgrowths of 1980s and 1990s WC reform, seem to have been successful interventions. States that have not implemented such reforms may be well advised to do so, for the wellbeing, productivity, profitability, and competitiveness of America's workforce is at stake. The state-level interventions represent departures from traditional federal OSHA hazard-specific standards. These alternative approaches now popular at the state level may be more effective than current federal standards and deserve additional evaluation and research.

Furthermore, the results of the analysis showed OSHA variables (inspections, consultations, and fines), industry effects, employer size distribution within industry groups, WC variables (benefit waiting periods and the ratio of maximum weekly benefit to average wages), employed population age distribution, union presence, and unemployment rates to have significant effects in the regression modeling. Because the cause of workplace injuries is multifactorial, the results demonstrate the importance of including various economic, demographic, and OSHA factors in the analysis of occupational injury rates. Evaluating the impact of workplace safety regulations requires careful consideration of all apparent economic, demographic, and OSHA causative factors before explanatory models are developed and tested. Continuing to refine and develop occupational injury rate explanatory models will help to improve the evaluation of workplace safety regulations in the future.

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