

Workplace Health and Safety Regulations: Impact of Enforcement and Consultation on Workers' Compensation Claims Rates in Washington State

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Background *There has been considerable debate in the public policy arena about the appropriate mix of regulatory enforcement and consultation in achieving desired health and safety behavior across industries. Recently there has been a shift in federal policy toward voluntary approaches and constraining the scope of enforcement programs, although there is little evidence that this might improve health and safety outcomes. To address this, we examined changes in lost time workers compensation claims rates for Washington State employers who had (1) no OSHA State Plan (WISHA) activity, (2) enforcement, (3) consultation, and (4) both types of visits.*

Methods *Compensable claims rates, hours, and WISHA activity were determined for each employer account with a single business location that had payroll hours reported for every quarter from 1997–2000 and more than 10 employees. We used a generalized estimating equations (GEE) approach to Poisson regression to model the association between WISHA activity and claims rate controlling for other external factors.*

Results *Controlling for previous claims rate and average size, claims rates for employers with WISHA enforcement activity declined 22.5% in fixed site industry SIC codes compared to 7% among employers with no WISHA activity ($P < 0.05$), and in non-fixed site SICs (e.g., construction) claims rates declined 12.8% for employers with enforcement activity compared to a 7.4% decline for those with no WISHA activity ($P > 0.10$). WISHA consultation activity was not associated with a greater decline in compensable claims rates (–2.3% for fixed sites and +3.5% for non-fixed sites). WISHA activity did not adversely affect worksite survivability through the study period.*

Conclusions *Enforcement inspections are significantly associated with decreasing compensable workers compensation claims rates especially for fixed site employers. We were unable to identify an association between consultation activities and decreasing claims rates.* Am. J. Ind. Med. 43:483–494, 2003. © 2003 Wiley-Liss, Inc.

KEY WORDS: *OSHA regulations; enforcement; consultation; injury claims rates; workers compensation*

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INTRODUCTION

There has been considerable discussion in the public policy arena about the roles of regulatory enforcement and consultation in achieving compliance with desired health and safety behavior in different industries. Recent legislative proposals at the federal level have sought to limit the Occupational Safety and Health Administration's (OSHA) flexibility to choose the mix of enforcement and consultative activities it deems most likely to achieve its mandate of preventing injuries and illnesses. Among these proposals are provisions that would reallocate OSHA funding toward a greater emphasis on providing consultations to employers; exemptions for small employers from routine enforcement visits; exemptions for employers with better than average safety records; the elimination of citations for the first instance of a violation; and a limit on the size of OSHA fines and the foreclosure of possible criminal sanctions. It has been argued that these approaches would hinder OSHA in its search for the optimal mixture of consultation and enforcement strategies. Such restrictions would reduce OSHA's effectiveness by reducing the probability of an inspection or a fine and thus, the economic incentive to comply [Shapiro and Rabinowitz, 1997]. Such approaches are based upon a premise lacking evidence: that the effectiveness of consultation visits in reducing occupational hazards is at least as great as that of inspections, and that this opportunity has been unduly neglected by OSHA in the past. A recently published report by the United States General Accounting Office (GAO) on OSHA's consultation program found that the agency was unable to measure the effect its consultation programs actually had on injuries and illnesses at participating work sites because it did not collect the data necessary to separate the effect of its consultation interventions from those of its inspections [GAO, 2001]. At the same time, congressional appropriations for state consultation programs grew by 50% from 1996 to 2001 and now account for more than 11% of OSHA's budget. In fact, this underestimates total OSHA expenditures to assist employers to comply with safety and health standards. If the federal compliance assistance program and the state consultation grants programs are combined, the actual shift in resources toward voluntary approaches is even more marked. From a total of \$43 million, or 14% of the total OSHA budget in 1994, this grew to \$107 million, or 24% of the total OSHA budget in 2001 [OMB, 1994–2002]. Over the same period of time, expenditures for both federal and state enforcement programs fell from 70% to 56% of the total budget. From 1994 to 2001, the total number of enforcement visits conducted by federal and state inspectors fell from 102,977 to 90,894. A continuing shift in federal-level priorities toward more consultative approaches is also shown in the rescinding of the federal ergonomics standard by Congress in March 2001 and the announcement by Labor Secretary Elaine Chao that future

efforts in ergonomics will emphasize voluntary approaches, such as guidelines and consultations.

Enforcement inspections seek to encourage safe workplaces and prevent injuries and illness through deterrence [McQuiston et al., 1998]. This deterrence takes two forms: one, businesses will be less likely to commit violations if they know these activities may be detected and penalized, "general deterrence," and two, a business violating the rules and laws will be less likely to repeat the violation if the business is caught and penalized, "specific deterrence." Some have argued that workers compensation incentives provide effective ways of reducing work-related injuries and illnesses, thereby making enforcement of OSHA regulations unnecessary [Mixon, 1900] while others have argued the reverse [Spieler, 1994] or that both are necessary [Smitha et al., 2001]. Few studies nationally have considered the relationship between OSHA activities and the rate of occupational injuries [Cooke and Gautschi, 1981; Bartel and Thomas, 1982; Gray and Scholz, 1993; McQuiston et al., 1998]. These have been primarily in the manufacturing sector and covering large employers. None of these studies have examined the question raised above: what is the effect of consultation without the threat of enforcement? What is the relative impact of enforcement as compared to consultation? Is there any evidence for a combination of consultation and enforcement having a greater impact than either strategy alone?

Washington State recognized the importance of worker health and safety protections in its 1889 constitution, and is the only state which administers both the state's workers compensation program and OSHA State Plan (WISHA) through the Department of Labor and Industries (L&I). L&I has had general safety standards as early as 1946 that required safety programs and joint labor-management safety committees [State of Washington, 1946]. L&I dedicates a significant portion of its resources to enforcement inspections and offers consultation services to employers requesting help to correct potential hazards and rule violations without the threat of penalty. Only limited analysis has been conducted to examine the relationship between workers compensation claims rates and WISHA activity [Nelson et al., 1997].

METHODS

Time Periods

Workers' compensation data from Washington State computerized systems requires time to mature. Given this limitation of the data, the following time periods were identified:

- Pre-Study Period State Fiscal Year (SFY) 1997–1998: compensable claims rates, reported hours, and WISHA activity were determined for each state fund employer

workers' compensation account. Accounts were selected for inclusion based on measurements from the pre-study period.

- Baseline Period SFY 1999: baseline compensable claims rates were measured and WISHA activity was characterized for each account ID.
- Measurement Period SFY 2000: the compensable claims rates and the resulting change in compensable claims rates from the baseline period were determined for each account ID and compared to those from the baseline period for various categories of WISHA activity.

These periods allowed for an 11-month period for claims data to mature before data extraction.

In order to minimize external influences and bias, the following inclusion criteria were applied to the population of accounts:

Only accounts reporting hours each quarter from SFY 1997–2000; State Fund accounts; accounts with a single business location; accounts with an average size of at least 10 FTEs-YR (fulltime equivalent employees per year) during the pre-study period; accounts with no WISHA activity during the pre-study period.

Rationale for Inclusion Criteria

To allow equivalent time for the rates to decrease during similar periods, only accounts that reported hours in equivalent time periods throughout the study period were selected. Because claims rates cannot be calculated for each business location at this time, only accounts with a single business location were included. Therefore, claims rates correspond directly to the business location in which the WISHA activity occurred. Only State Fund (SF) accounts were included as only 4% of self-insured (SI) accounts have a single business location. Accounts were limited to those with an average pre-period size of at least 10 FTEs-YR. Accounts with less than 10 FTEs-YR have widely varying claims rates, generally speaking, since the influence of a single claim can be substantial. In order to reduce the influence from previous WISHA activity, only accounts with no WISHA activity during the pre-study period were included. Finally, analysis was conducted separately for accounts with “fixed site” SIC codes compared to accounts with other SIC (“non-fixed site”). Fixed site SIC codes included agriculture; manufacturing; wholesale trade; retail trade; finance, insurance, and real estate; services; and the executive, legislative, and general government (two-digit SICs 01, 02, 20–39, 50–87, 91). Such a categorization was developed since it was assumed that WISHA effectiveness might vary between these two categories of industry. Given the inclusion criteria, we were unable to assess each two-digit SIC separately since the number of available accounts would be small.

Data Analysis

Included accounts were followed for 4 years on a quarterly basis beginning with the pre-study period. The compensable claims and number of hours reported were recorded for each quarter of the study period as was WISHA activity. Closing dates were used to determine quarter of WISHA activity. Yearly compensable claims rates for each account were determined [$(no. \text{ of compensable claims/work-hours}) \times 2,000 \text{ hr} \times 100$].

Changes in claims rates for accounts with and without WISHA activity were compared through univariate and multivariate analysis. For univariate analysis, the difference in the compensable claims rates for each account ID between the measurement period and the baseline period was calculated. The average difference in annual claims rates was then determined for the different groups of accounts based on WISHA activity. Statistical comparisons of the average differences were conducted using the Wilcoxon Rank Sum test for two category comparisons, and the Kruskal-Wallis test for >2 category comparisons.

For univariate analysis, WISHA status was categorized into four groups for the baseline period:

- None—No WISHA activity closing during SFY 1999.
- Consultation Only—one or more consultation activities closing during SFY 1999.
- Enforcement Only—one or more enforcement activities closing during SFY 1999.
- Both—At least one consultation and one enforcement activity closing during SFY 1999.

Other variables considered during univariate analysis included claims rate during SFY 1997 (using actual claims rate or categorized into quartiles for non-zero claims rate and a separate category for those with zero claims rate), average size based on SFY 1997–1998 categorized into quartiles, SIC code categories (fixed vs. non-fixed), and industry sector categories.

For multivariate analysis, a Poisson model was constructed. For count data, such as the number of compensable claims, the Poisson distribution is well suited [Kleinbaum et al., 1988; Allison and Institute, 1999]. Multivariate Poisson models are especially well suited for estimation of rates based on count data. However, Poisson models often suffer from over-dispersion; therefore standard errors were adjusted for over-dispersion as previously suggested [Allison, 1999]. In addition, we included multiple quarterly measures of claims rates for each account ID. Because these observations are not independent but are longitudinal, we used a generalized estimating equations (GEE) approach to estimate the Poisson models. In our models, an autoregressive correlation matrix was specified although other models were attempted. Because the results and conclusions were

similar regardless of the matrix, and the autoregressive matrix seemed most appropriate for this study's data, we present the results using this matrix only. Using this model, the compensable claims rates for each quarter from SFY 1999 through SFY 2000 were modeled adjusting for WISHA activity, average SFY 1997–1998 size, SFY 1997 claims rate, and SIC code categories as possible.

RESULTS

Selection of Account Population

For SFY 1997–2000, we identified 263,744 unique accounts (Fig. 1). Of these, 28% reported >0 hours every quarter from SFY 1997–2000 including State Fund (SF) and Self Insured (SI) accounts.

Of the 74,217 accounts reporting hours >0 in every quarter from SFY 1997–2000, 73,895 (>99%) were State Fund. Of those accounts, 83% were identified as having a single business location. Of these accounts, only 11,176 accounts (18%) reported at least 10 FTEs-YR during SFY 1997–1998. Hence, of the 263,744 identified accounts, only 4% were State Fund, single business locations reporting at least 10 FTEs-YR during SFY 1997–1998 and hours >0 throughout all quarters SFY 1997–2000.

WISHA Visits

From the WISHA Integrated Management Information System (IMIS) database, 18,269 records regarding WISHA consultation activity were downloaded with 8,522 unique accounts identified; and 103,217 records regarding WISHA

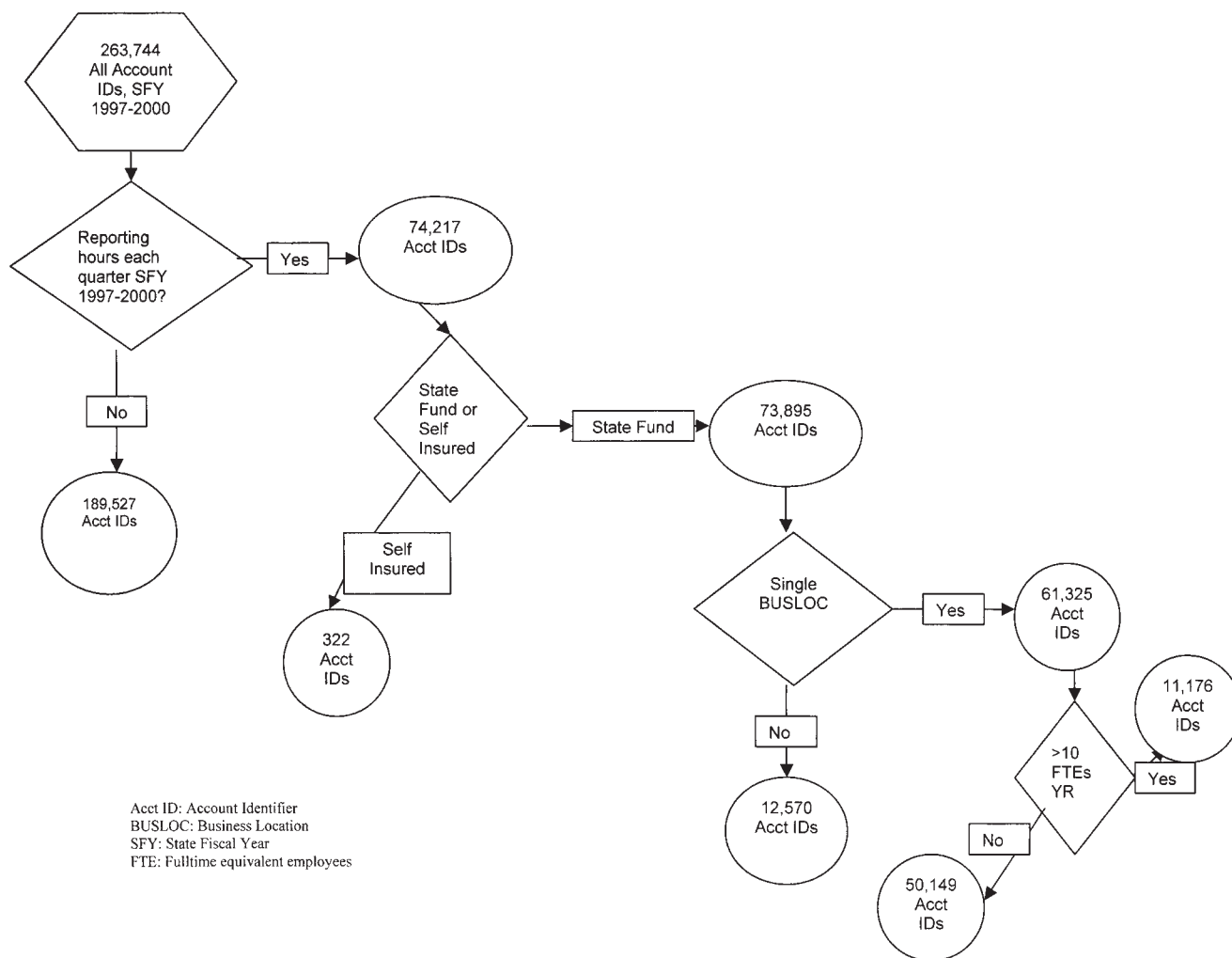


FIGURE 1. Employer records were extracted from the workers' compensation database using the criteria illustrated above. The number of employers remaining after application of each criterion is listed. Abbreviations: Acct ID, account identifier; BUSLOC, business location; SFY, state fiscal year; FTE, fulltime equivalent employees.

enforcement activity were downloaded with 37,335 distinct accounts identified. Figure 2 describes the selection and matching process of WISHA activities to hours and claims.

Of the 11,176 accounts identified as of primary interest, accounts with WISHA activity during the pre-study period were excluded leaving 8,929 (80%) accounts. Through the baseline period (SFY 1999), only 9.6% of enforcement visits, 10.2% of consultation visits, and 9.7% of programmed enforcement visits occurred in the selected 8,929 accounts.

Compensable Claims Rates

From SFY 1999 to SFY 2000, the average compensable claims rates decreased 5.5% among the 8,929 remaining accounts. For comparison purposes, the average compensable claims rate for non-sampled, but surviving accounts for the same period decreased 2.1%. For fixed site SIC accounts, the average compensable claims rates decreased 5.3% while compensable claims rates decreased 5.9% for non-fixed SIC accounts.

Changes in the claims rates were first examined through univariate comparisons of average claims rates for groups of accounts categorized by WISHA activity. (See Table IA and Fig. 3.)

For fixed site SIC accounts, from the baseline period (SFY 1999) to the measurement period (SFY 2000), the compensable claims rates decreased 21.0% for accounts with any WISHA activity compared to 3.0% for accounts with no WISHA activity ($P < 0.002$). Among non-fixed site SIC accounts, compensable claims rates decreased 11.0% for accounts with any WISHA activity compared to 4.6% for accounts with no WISHA activity but this change was not statistically significant.

WISHA activity was then broken out into four exclusive groups: accounts with no activity, those with consultation visit(s) only, those with enforcement visit(s) only, and those with both consultation and enforcement visits.

For fixed site SIC accounts, compensable claims rates increased 4.1% among accounts with WISHA consultation activity. Compensable claims rates decreased 27.5% among accounts with WISHA enforcement activity during the measurement period ($P < 0.002$), and compensable claims rates decreased 24.6% among accounts with both consultation and enforcement activity. Compensable claims rates decreased 3.0% among accounts with no WISHA activity during the measurement period.

Similarly, among accounts in non-fixed SIC codes, compensable claims rates increased 8.3% for consultation

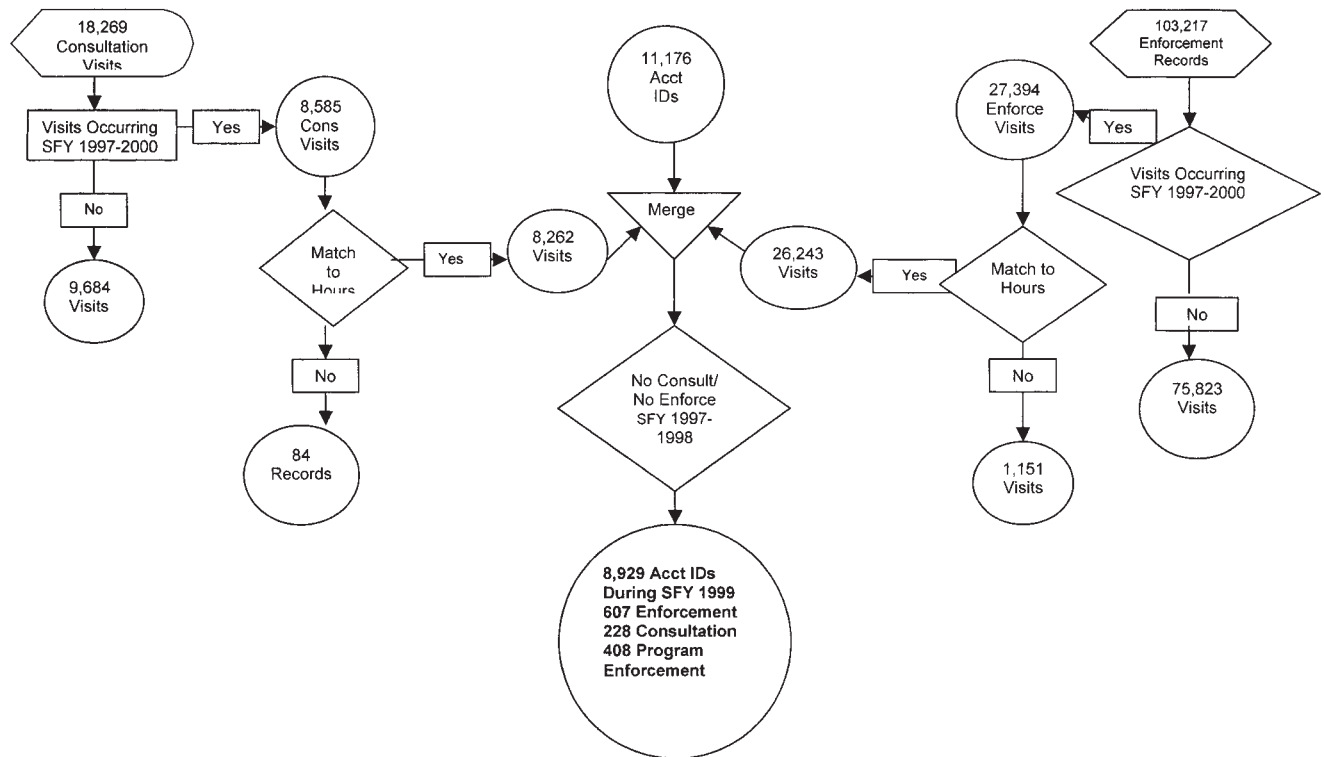


FIGURE 2. Employer records extracted from the workers' compensation database were matched to records of WISHA enforcement and consultation activity. The number of enforcement and consultation records matching to employer records previously extracted and those meeting the specified criteria are listed. Abbreviations: Acct ID, account identifier; SFY, state fiscal year; Cons, consultation; Enforce, enforcement.

TABLE IA. Univariate Associations Between Compensable Claim Rates and WISHA Activity for Fixed and Non-Fixed SIC

		Compensable rates per 100 FTEs				Rate difference					
		SFY 1997	SFY 1998	SFY 1999	SFY 2000	SFY 2000–SFY 1999		SFY 2000–SFY 1998			
		N	Mean	Mean	Mean	Mean	%	Mean	%		
Excluded accounts ^a											
	All	65288	2.46	2.51	2.37	2.32	-0.05	-2.1	-0.19	-7.7	
WISHA categories		SIC categories									
	All	All	8929	2.06	1.96	1.95	1.85	-0.11	-5.5	-0.11	-5.6
	All	Fixed SIC	7424	1.62	1.58	1.53	1.45	-0.08	-5.3	-0.13	-8.1
	All	Non-fixed SIC	1505	4.23	3.84	4.04	3.81	-0.24	-5.9	-0.03	-0.8
No WISHA	Fixed SIC	7042	1.49	1.46	1.41	1.36	-0.04	-3.0	-0.10	-6.8	
WISHA	Fixed SIC	382	4.02	3.66	3.81	3.01	-0.80	-21.0	-0.65	-17.7	
No WISHA	Non-fixed SIC	1270	3.96	3.64	3.86	3.68	-0.18	-4.6	0.04	1.1	
WISHA	Non-fixed SIC	235	5.69	4.87	5.02	4.47	-0.55	-11.0	-0.40	-8.2	
No WISHA	Fixed SIC	7042	1.49	1.46	1.41	1.36	-0.04	-3.0	-0.10	-6.8	
Consultation	Fixed SIC	99	3.68	3.22	2.93	3.05	0.12	4.1	-0.17	-5.3	
Enforcement	Fixed SIC	254	4.09	3.77	4.18	3.03	-1.15	-27.5	-0.74	-19.6	
Both	Fixed SIC	29	4.53	4.22	3.66	2.76	-0.90	-24.6	-1.46	-34.6	
No WISHA	Non-fixed SIC	1270	3.96	3.64	3.86	3.68	-0.18	-4.6	0.04	1.1	
Consultation	Non-fixed SIC	39	7.02	4.15	5.23	5.66	0.43	8.3	1.51	36.4	
Enforcement	Non-fixed SIC	186	5.60	5.06	5.07	4.28	-0.80	-15.7	-0.78	-15.4	
Both	Non-fixed SIC	10	2.30	4.19	3.25	3.38	0.14	4.2	-0.81	-19.3	

^aOnly surviving accounts used.

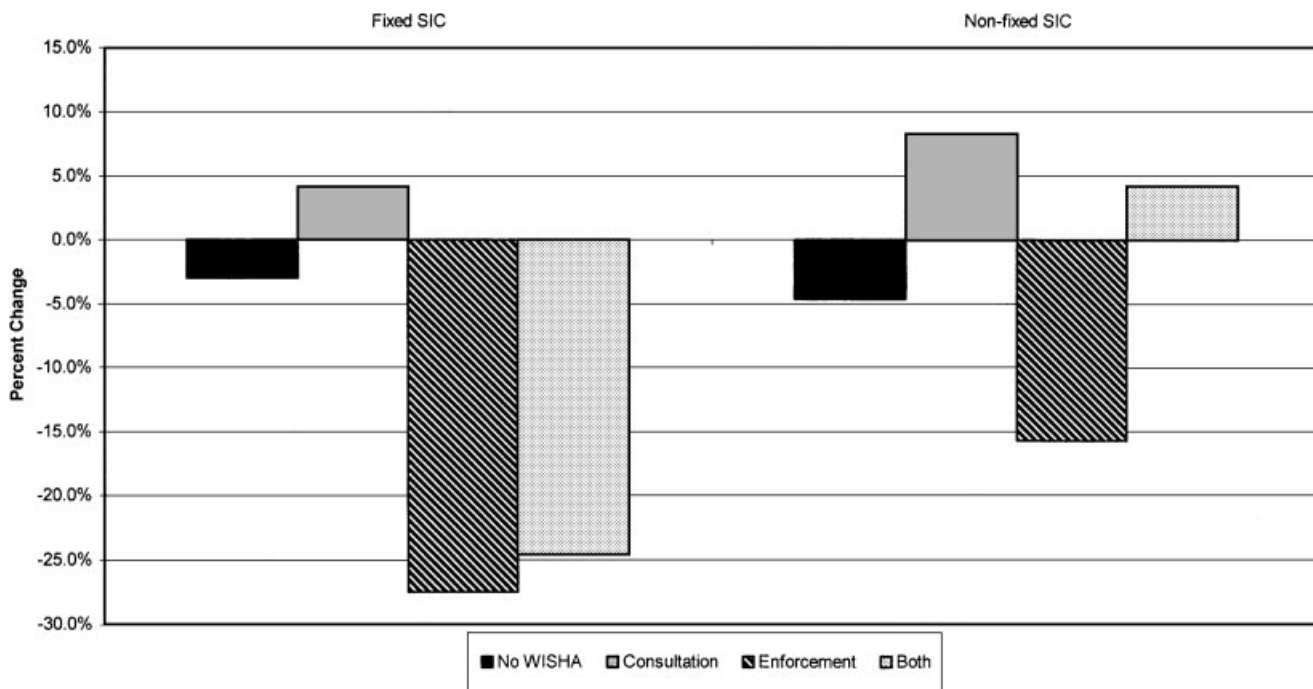


FIGURE 3. The percent change in average compensable claims rates for State Fund Accounts SFY 1999–SFY 2000. Abbreviations: SFY, state fiscal year.

activity, decreased 15.7% for enforcement activity, and increased 4.2% for enforcement and consultation activity, but for accounts with no WISHA activity during the measurement period, compensable claims rates decreased 4.6% ($P < 0.41$). The increase of compensable claims rates among accounts with both consultation and enforcement activity is based on a small number of accounts (10).

To eliminate possible bias from pre-period claims rate, associations between WISHA activity and compensable claims rates were examined, with the analysis focused on specific quartiles based on the SFY 1997 compensable claims rate, i.e., accounts with higher SFY 1997 compensable claims rates were compared to each other while accounts with low SFY 1997 claim rate were compared separately (data not shown). In general, accounts with enforcement activity were associated with a greater decrease in the compensable claims rate in the fixed site SIC accounts. This association was observed among all categories except those with the lowest non-zero claims rate. Among the non-fixed SIC accounts, this same association was observed among accounts with the highest SFY 1997 rate or a SFY 1997 rate of zero. Because several categories have a small number of accounts (<10), the results for consultation activities tend to vary more widely than previous comparisons.

Associations between WISHA activity and compensable claims rates were also examined for each category of account size, <50 and ≥50 FTEs-YR (Table IB). Previously observed associations between WISHA activity and claims

rates were apparent among smaller accounts. Indeed, the impact of enforcement visits on claims rates was somewhat greater among smaller accounts than they were among larger accounts. Among larger accounts in fixed SIC, consultation activities were associated with a larger decrease in claims rates unlike previous observations, although this was not statistically significant ($P < 0.40$). The number of non-fixed SIC large accounts was small, and claim rates tend to vary more widely.

WISHA enforcement activity was then divided into programmed and unprogrammed (“complaint-driven”) inspections for those accounts with enforcement activity only. Among accounts with fixed site SIC, compensable claims rates decreased 24.6% and 36.0% between 1999 and 2000 for programmed and unprogrammed inspections, respectively ($P < 0.003$). For accounts with non-fixed site SIC, the decreases were not statistically significant.

To adjust for size and pre-period compensable claims rate, two multivariate Poisson models were estimated (Table II). The first model compares rates from SFY 2000 to rates from SFY 1999. The second model calculates the average decrease between each quarter over the period SFY 1999–SFY 2000. Both models control for SFY 1997 rates, average SFY 1997–1998 size, and SIC category when possible. Similar results were found in both multivariate models. In the first model, for fixed site SIC, compensable claims rates for accounts with no WISHA activity decreased 7% from SFY 1999 to SFY 2000. Accounts with WISHA

TABLE IB. Univariate Associations Between Compensable Claim Rates and WISHA Activity for Fixed and Non-Fixed SIC Stratified by SFY 1997 Account Average Size (<50 or ≥50 FTEs-YR)

WISHA categories	SIC categories	N	SFY 1997	SFY 1998	SFY 1999	SFY 2000	SFY 2000–SFY 1999		SFY 2000–SFY 1998	
			Mean	Mean	Mean	Mean	Mean	%	Mean	%
<50 FTEs-YR										
No WISHA	Fixed SIC	6192	1.48	1.46	1.39	1.36	-0.03	-1.9	-0.10	-6.8
Consultation	Fixed SIC	69	3.66	3.14	2.68	3.21	0.53	19.9	0.07	2.2
Enforcement	Fixed SIC	205	4.19	3.93	4.40	3.09	-1.31	-29.8	-0.85	-21.6
Both	Fixed SIC	19	4.23	4.32	2.86	2.07	-0.79	-27.6	-2.24	-52.0
No WISHA	Non-fixed SIC	1146	4.06	3.69	3.95	3.79	-0.17	-4.2	0.10	2.7
Consultation	Non-fixed SIC	32	7.29	4.45	5.49	6.06	0.56	10.3	1.61	36.1
Enforcement	Non-fixed SIC	163	5.87	4.96	5.28	4.35	-0.93	-17.7	-0.61	-12.2
Both	Non-fixed SIC	8	1.89	4.09	3.25	3.73	0.48	14.8	-0.36	-8.8
≥50 FTEs-YR										
No WISHA	Fixed SIC	850	1.57	1.47	1.53	1.38	-0.16	-10.2	-0.10	-6.6
Consultation	Fixed SIC	30	3.72	3.41	3.52	2.69	-0.83	-23.6	-0.72	-21.2
Enforcement	Fixed SIC	49	3.68	3.07	3.26	2.79	-0.47	-14.5	-0.28	-9.1
Both	Fixed SIC	10	5.10	4.04	5.18	4.07	-1.11	-21.4	0.03	0.8
No WISHA	Non-fixed SIC	124	3.04	3.22	3.03	2.72	-0.31	-10.2	-0.49	-15.4
Consultation	Non-fixed SIC	7	5.79	2.80	4.04	3.87	-0.17	-4.1	1.08	38.6
Enforcement	Non-fixed SIC	23	3.71	5.78	3.59	3.75	0.17	4.7	-2.02	-35.0
Both	Non-fixed SIC	2	3.93	4.60	3.24	2.00	-1.23	-38.1	-2.60	-56.5

TABLE II. Multivariate Associations Between Compensable Claim Rates and WISHA Activity for Fixed and Non-Fixed SIC

Estimator	Fixed SIC			Non-fixed SIC		
	Estimate	Standard error	P-value	Estimate	Standard error	P-value
Model 1 ^a						
Study period ^b	-0.0730	0.0260	0.0049	-0.0774	0.0423	0.0678
Enforcement	0.5745	0.0762	<0.0001	0.1553	0.0854	0.1242
Enforcement* study period	-0.1816	0.0794	0.0268	-0.0600	0.0914	0.5103
Consultation	0.2333	0.1190	0.0190	-0.0482	0.1576	0.9580
Consultation* study period	0.0497	0.1158	0.6668	0.1114	0.1518	0.4615
Average size SFY 1997 – 1998			<0.0001			0.0183
SFY 1997 compensable rate (quartiles)			<0.0001			<0.0001
Estimated %difference SFY 2000 vs. SFY 1999 based on model estimates						
No WISHA	-7.0%			-7.4%		
Enforcement	-22.5%			-12.8%		
Consultation	-2.3%			3.5%		
Model 2 ^a						
Period ^c	-0.0198	0.0057	0.0006	-0.0028	0.0090	0.7523
Enforcement	1.0260	0.2253	<0.0001	0.5399	0.2472	0.0383
Enforcement* period	-0.0437	0.0170	0.0133	-0.0334	0.0193	0.0860
Consultation	0.1150	0.3666	0.7568	0.3867	0.5170	0.4652
Consultation* period	0.0115	0.0276	0.6758	-0.0304	0.0399	0.4513
Average size SFY 1997 – 1998			<0.0001			0.0185
SFY 1997 compensable rate (quartiles)			<0.0001			<0.0001
Estimated %difference per 1 quarter						
No WISHA	-2.0%			-0.3%		
Enforcement	-6.2%			-3.6%		
Consultation	-0.8%			-3.3%		
Estimated %difference per 4 quarters						
No WISHA	-7.6%			-1.1%		
Enforcement	-22.4%			-13.5%		
Consultation	-3.3%			-12.4%		

^aMultivariate estimates from a repeated measures Poisson model.

^bStudy period compares SFY 2000 to SFY 1999.

^cPeriod is a continuous variable from 1 to 8 representing each quarter from SFY 1999 through SFY 2000.

enforcement activity decreased 16% more than accounts with no WISHA activity ($P < 0.03$), but accounts with consultation activity decreased 5% less than accounts with no WISHA activity ($P < 0.70$). In a second model for fixed SIC, claims rates for accounts with WISHA enforcement activity decreased 15% more than accounts with no WISHA activity per four quarters ($P < 0.02$). Consultation activity was associated with a small increase, 4% per four quarters ($P < 0.68$).

For non-fixed SIC codes, claims rates among those with WISHA enforcement activity decreased 5% more than accounts with no WISHA activity. Claims rates for accounts with consultation activity increased 11% compared to accounts with no WISHA activity. In the second model, claims

rates for accounts with WISHA enforcement activity decreased 12% more than accounts with no WISHA activity per four quarters ($P < 0.09$), and claims rates for accounts with WISHA consultation activity also decreased 11% more than accounts with no WISHA activity per four quarters ($P < 0.46$).

Only the larger decline in compensable claims rates for fixed site SIC accounts with enforcement activity was statistically different from accounts with no WISHA activity. The relationship between claims rates and consultation activity for fixed SIC accounts as well as the relationship between claims rates and any WISHA activity for non-fixed SIC accounts was not statistically significant. These results were very similar to the results from the univariate analysis except

for the effect of consultation activities among non-fixed SIC in Model 2, which showed a decrease in claims rates. But this decline was not statistically significant and may be a spurious association due to the large standard error and small sample size.

Additional multivariate models classifying WISHA activity into programmed and unprogrammed enforcement showed similar results (Table III), with statistically significant decreases in claims rates for fixed site accounts with enforcement activity. For non-fixed site accounts with enforcement activity claims rates also decreased but this was not statistically significant. Consultation activity once again was not associated with a decline in claims rate over this period.

DISCUSSION

This study identified a strong association between WISHA enforcement visits and decreasing compensable workers compensation claims rates among employers with single business locations and fixed site SICs while controlling for size and pre-study claims rate. At worksites that experienced WISHA enforcement activity there was a 25% greater decline in claims rates at fixed site SICs than there was at worksites with no WISHA enforcement activity. This reduction is similar in degree to that found for a 3-year follow-up period by Gray and Scholz [1993]. In contrast, our study is not restricted to large workplaces in regularly inspected firms. While similar trends were identified for non-fixed site SIC employers (an 11% greater decline), they were not statistically significant. Non-statistically significant increases in compensable claims rates were associated with consultation visits. Additionally, WISHA enforcement activity was not associated with decreasing survivability of firms over the study period compared to those without WISHA activity.

If plant managers, when setting health and safety policies, only followed a narrow expected utility approach in which the costs of investments in compliance are weighed against the probability of the detection of non-compliance and the size of the penalties which would result, one would expect only incremental, narrowly focused safety improvements following an inspection. But the magnitude of the decline in claims rates following inspections found in this study lends support to the view that enforcement visits may trigger a re-shuffling of managerial priorities and a greater attention paid to safety and health improvement opportunities throughout a worksite [Gray and Scholz, 1993].

The strengths of this study include a repeated measures approach (GEE) which follows each worksite in a state that has a long history of requiring joint health and safety committees and written safety programs. This allowed us to look specifically at WISHA activity rather than a combination of WISHA and workers compensation regulations [Smitha

et al., 2001]. Additionally, it includes primarily small to medium sized worksites in many different industries whereas other studies have focused on large manufacturing employers [Bartel and Thomas, 1982; Gray and Scholz, 1993].

Ruser [1993] used a mixed model to look at count data (number of claims) and severity of claims simultaneously. He used a negative binomial model because a Poisson model had over-dispersion. We chose to adjust for over-dispersion in a Poisson model using PSCALE [Allison, 1999]. We examined our data with a negative binomial model and found more precision (smaller *P* values) but no difference in results and conclusions. Other models with alternative study designs are appropriate areas for future research.

Because this type of study design assumes all accounts included in the analysis are similar to one another except for their WISHA activity, numerous limitations in this study design may be identified.

Factors such as account size and the account's SFY 1997 compensable claims rate were controlled for in the analysis. While these factors are related to WISHA activity, they were not strongly related to compensable claim rate decreases in the measurement years. Hence, these factors did not strongly influence the results.

However, accounts with WISHA activity did have consistently higher average SFY 1997 claims rates than those accounts with no activity. This may be a result of WISHA targeting activities (only partially based on previous claims rates). Therefore, one can hypothesize that the differences in the decline of claims rates were a result of regression to the mean. However, the study design allows claims rates to be controlled for in the analysis. When the effect of WISHA activity was stratified by SFY 1997 claims rates, the association between WISHA activity and decreasing claims rates was noticeable in all strata except one. That was the lowest non-zero claims rates stratum. To further examine the issue of regression to the mean, the association between WISHA activity and decreasing claims rates was examined using only the accounts in the top 10% and top 5% of SFY 1997 claims rates. Again, similar associations were observed. Hence, it is not likely that the magnitude of the SFY 1997 claims rates explains the observed associations between WISHA activity and decreasing claims rates. We also included 1997 claims rate as a continuous variable in the multivariate analyses. The *P*-value for enforcement dropped to 0.052 from 0.027 in model 1 and to 0.038 from 0.013 in model 2 (Table II).

There is some evidence that WISHA activity may increase claims rates before the subsequent decrease. From SFY 1998–1999, accounts with WISHA activity generally increased slightly more than those accounts with no WISHA activity. The increase may possibly be due to increased reporting immediately after WISHA activity. This increase could elevate the magnitude of the change in WISHA accounts. This increase was higher for accounts with unpro-

grammed enforcement inspections. However with the exception of unprogrammed visits, the increases in claims rates in SFY 1999 were small compared to the decreases by SFY 2000. Further, similar associations were observed using SFY 1998 as the baseline year rather than SFY 1999. Among accounts with fixed site SIC, compensable claims rates decreased 6.8, 5.3, 19.6, and 34.6% between SFY 1998 and SFY 2000 for accounts with no WISHA activity, consultation activity, enforcement activity and consultation/enforcement activity respectively (Table IA).

Temporal association between WISHA activity and the changes in claims rates could be established using the current study design. Included accounts did not have any WISHA activity close during SFY 1997–SFY 1998. WISHA activity was then categorized in SFY 1999, and the changes in the claims rates were measured during the next year SFY 2000. Therefore, WISHA activity occurred first, and then the changes in claims rates occurred.

It could also be hypothesized that those accounts with WISHA activity were less likely to survive all 16 quarters of the study period. Among the cohort of accounts which satisfied all selection criteria but the survival criteria, 76% of 11,814 accounts were included in the study. Among accounts that had WISHA activity a greater proportion survived all 16 quarters: 80% for consultation, 83% for enforcement, and 89% for consultation/enforcement, whereas only 75% of the no WISHA accounts survived all 16 quarters, ($\chi^2 = 23.3567$, $P < 0.0001$). The same general pattern of account survival was noticeable stratifying survival rates by average SFY 1997–1998 account size and SFY 1997 claims rates except for accounts with a zero claims rate in SFY 1997. Among accounts with a zero claims rate, those with WISHA activity were as likely to survive as those with no WISHA activity ($\chi^2 = 1.5342$, $P < 0.68$). The finding that firms scrutinized by WISHA were actually more likely to survive through the 4-year period of study is significant when viewed in the context of the political debate over the burden of occupational safety and health regulation. As with a previous study by the now-defunct U.S. Congress Office of Technology Assessment, this analysis supports the claim that such standards do not impose an intolerable compliance burden on business [OTA, 1995].

A strength of this study design is that limiting the cohort to meeting specific criteria minimizes external influences. However, only 10% of WISHA visits in the same time frame are represented in this cohort. Since the remaining accounts differ by important factors such as self-insured status, size, and the number of business locations, it does not necessarily follow that the results can be extended to WISHA activity overall. Those account populations in which most WISHA activity occurs include large self-insured accounts; medium and large State Fund accounts with multiple business locations, and medium State Fund accounts with single business locations. This study focused on medium-sized, State Fund

accounts with a single business location in fixed and non-fixed SIC categories due to constraints in the L&I databases. Studies at the business location level, which would allow for the inclusion of multiple business location accounts, would extend the coverage of the analysis, but they cannot be currently completed as worker hours and claims are reported only at the account level.

Additionally, when we looked at overall accounts that did not meet our study criteria of size or single location, the compensable claims rates were higher over the study period. This suggests that exclusion was necessary but may also have underestimated potential effect of WISHA visits. Claims rates for very small employers (<10 FTE) were highly variable, making comparisons between before and after intervention less efficient.

Only a short follow-up time is available for this study design. It is unknown whether the decrease in claims rates for accounts with enforcement activity will become similar to other accounts as time passes. Analysis using the same time frames should be conducted in another year when the measurement year can be extended to SFY 2001. Because of the relatively short follow-up time, accounts with visits in quarter 1 of the baseline period had a relatively longer time for claim rates to decrease when compared to accounts with visits closing in quarter 4 of the baseline period. Additional analysis, which separated accounts by their quarter of visit, suggested there was similar association between WISHA activity and the average difference of claims rates post 1 year from their first visit.

Finer distinctions in SIC codes were also not possible for this analysis. Often, there were inadequate numbers of accounts for each two-digit SIC code. Accounts were divided into fixed and non-fixed for this analysis. Estimates of WISHA effectiveness did vary by this categorization. Only through using less restrictive criteria might estimates be obtained by each SIC code.

It should be noted that, as in the Gray and Scholz study, we focused only on the “specific” form of deterrence, where the behavior of firms actually inspected is tracked. If the broader aim of this project is to measure the overall effect which the existence of occupational safety and health standards have on the level of workplace injuries, then this study is likely to understate this impact. This study does not take into account the “general deterrence” effect whereby all companies improve and maintain safety because they know that failure to do so may be detected and penalized. Neither has this study accounted for the effect which OSHA standards may have had on the nature of technological change and on the level of safety education received by management and workers [Gray and Scholz, 1993]. Taken together, this suggests that the impact measured by this study is if anything an understatement of the total impact which the existence of occupational safety and health standards has on the level of injuries and illnesses.

Finally, the associations between WISHA activity and decreasing claims rates identified in this study do not provide sufficient evidence for a causal relationship. To establish causality it would be necessary to demonstrate the mechanism by which claims rates decrease. One may expect those accounts without WISHA activity to have not made any changes in workplace safety while those accounts with WISHA activity to correct hazards. On the other hand, WISHA activity may lead to suppression of claims, which also leads to the observed association. The lack of association between consultation activities and decreasing claims rates does not by itself prove that consultation is an ineffective activity whether alone or in combination with enforcement visits. The observed association does show that the simple presence of WISHA in the workplace is not necessarily associated with decreasing claims rates because there was no decrease with consultation alone. Our results suggest, but do not prove, that the threat of penalty does influence future claims rates. Follow-up data after WISHA activity occurs would provide useful information regarding mechanisms by which claims decrease. Information on the abatement of hazards is now being collected for enforcement visits. This should be useful in future studies.

CONCLUSIONS

In conclusion, this study finds that the magnitude of the decline in claims rate following inspections suggests that enforcement activity may trigger broad improvements in safety practices at visited workplaces; the similar results for small firms suggest that opportunities for improved safety among smaller businesses should not be neglected; and the ability of firms to survive is not affected by whether they are subjected to a WISHA inspection.

Taken in the context of recent calls to shift OSHA resources away from enforcement and toward consultation, this study suggests such moves may be counterproductive to reaching the goal of improved safety and health.

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