

# Falls in Construction: Injury Rates for OSHA-Inspected Employers Before and After Citation for Violating the Washington State Fall Protection Standard

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Nancy A. Nelson, PhD, MPH,\* Joel Kaufman, MD, MPH, John Kalat, BS,  
Barbara Silverstein, PhD, MPH

*This study examined the relationship between Washington's fall protection standard and injuries in construction workers. Workers' compensation claim rates for falls were examined for employers that were cited for violating the standard over the 1991-1992 period. Fall injury rates for the periods before and after inspections were compared. Claims for a control group of employers that had not been cited were also examined. For the 784 cited employers, the claim rate for compensable fall injuries decreased from 1.78 to 1.39 per 200,000 hours worked for the one-year periods before and after inspection. For the control group (n = 8,301), the claim rate decreased from 1.04 to 0.95 per 200,000 hours. Cited employers were 2.3 times as likely as control employers (p < 0.0001) to experience a claim rate reduction, after adjustment for employer size and type of business. Results suggested that industry-wide fall injury rates might be expected to decrease if more employers were inspected. Am. J. Ind. Med. 31:296-302, 1997. © 1997 Wiley-Liss, Inc.*

**KEY WORDS:** fall injuries; fall protection standard; OSHA regulations

## INTRODUCTION

The construction industry experiences high rates of work-related morbidity and mortality. In 1994, U.S. construction workers experienced a death rate of 15 per 100,000 employees, the third-highest fatality rate by major industrial category (Bureau of Labor Statistics, 1995a). In the U.S. Bureau of Labor Statistics' 1994 Annual Survey of Occupational Injuries and Illnesses, the construction industry had an injury and illness rate of 11.8 per 100 employees, the second highest of all major industrial categories [Bureau of Labor Statistics, 1995b]. The 1994 injury and illness rate for

Washington construction workers was 17.6 per 100 employees [State of Washington, 1995].

Falls represent a significant portion of occupational injuries to construction workers. In 1992, 29.2% of occupational fatalities in construction workers were due to falls and were the most common cause of death for workers in that industry [U.S. Bureau of Labor Statistics, 1994].

The U.S. Occupational Safety and Health Act, enacted in 1970, incorporated a number of existing federal provisions, including those of the Construction Safety Act, in an attempt to protect construction workers from occupational safety hazards. These included several regulations related to fall protection: use of personal protective equipment, such as safety nets, safety belts, lifelines, and lanyards, and specifications regarding practices related to floor and wall openings and stairways. For more than 15 years the Occupational Safety and Health Administration (OSHA) worked to revise fall protection regulations; in 1994 it promulgated the revised Safety Standard for Fall Protection in the Construction Industry.

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Safety and Health Assessment and Research for Prevention program, Washington State Department of Labor and Industries, Olympia, Washington.

\*Correspondence to: Nancy Nelson, Ph.D., SHARP, Department of Labor and Industries, State of Washington, P.O. Box 44330, Olympia, Washington 98504-4330.

Washington State enacted a vertical fall protection standard for the construction industry in February 1991, well before the federal fall protection standards became effective. The Washington regulations were consolidated into the Fall Restraint and Fall Arrest Standard (Washington Administrative Code 296-155). In addition to personal protective equipment, the standard requires a fall protection work plan which identifies employees at risk of a fall hazard of ten feet or more. At the time the standard was developed and enacted, widespread informational campaigns and workshop education programs for employers and employees were undertaken by the State Department of Labor and Industries, which is responsible for enforcement of workplace health and safety standards in Washington.

Few studies have examined the effectiveness of Washington's standard in reducing or preventing injuries. In preliminary analyses, the Department of Labor and Industries examined workers' compensation claims data for fall injuries over the relevant time period for construction employers: Over the 1989–1993 period, claim rates for construction falls decreased, as did rates of hospitalization and other injury measures related to the claims [unpublished data]. However, overall claim rates for all industries combined also decreased over this period; in fact, the decrease in slope was statistically significantly greater for the overall claim rate than for fall claim rates in the construction industry.

The current study describes a further attempt to examine the effect of the fall protection standard on fall injury rates in Washington's construction industry. Workers' compensation claim rates were used as the measure of injury, but instead of examining ecological trends across the entire industry, we selected for study only employers certain to be aware of the standard and the penalties for noncompliance. Fall injury rates were examined for employers who were visited by state plan OSHA safety inspectors and cited for violating the standard over the 1991–1992 period. The study hypothesis was that injury rates for falls would be significantly lower for construction employers after they were inspected and cited for violating the fall protection standard.

## MATERIALS AND METHODS

### Workers' Compensation Claims

Workers' compensation claims data and employment data for the years 1989–1993 were obtained from the Washington State Department of Labor and Industries files. In Washington, employers are required to obtain workers' compensation insurance through the department's Industrial Insurance system unless they are able to self-insure (with the exception of those who are self-employed, who are not required to have coverage). Approximately two-thirds of

the workers in the state are covered by the department's State Fund, while the rest (who work chiefly for the largest employers) are covered by their self-insured employers.

In this study, claims are limited to those for employers insured by the State Fund, for which more detailed employment data are available.

Injured employees may be reimbursed for medical treatment costs only (referred to as "noncompensable" claims) and/or for lost time from work (referred to as "compensable" claims, which must have resulted in four or more days of lost work time).

Claims are coded as to industry and occupation of the claimant; injury source, nature, and body part, and type of event or exposure that caused the injury are coded using Z16.2 codes developed by the American National Standards Institute.

The injury outcome was defined as compensable claims with selected Z-16 Injury Event or Exposure codes for falls 030–033 and 035–039 (fall from elevation, platform, or ladder; fall from piled matter; fall on stairs; fall into openings; fall from roof; and fall to lower level).

### Employment Data

Information on employment is reported to the Department of Labor and Industries by State Fund employers as number of hours worked by employees. Injury rates were calculated assuming that each full-time employee works 2,000 hours per year (40 hours per week for 50 weeks per year). This assumption may underestimate true injury rates, as construction employees average somewhat fewer hours worked per year [Ringen et al, 1995].

### Study Population

The Washington State Department of Labor and Industries is authorized by OSHA to conduct workplace inspections in state workplaces and enforce federal and state safety and health regulations. Excluded from the department's jurisdiction are federal employees, railroad workers, and maritime employers. All other employers are subject to inspection by state staff, regardless of size (number of employees). The department maintains computer files on state employers that include Standard Industrial Classification (SIC) codes.

Two groups were identified for inclusion in the study: 1) the group of construction employers (in SIC codes 15–17) that were insured for workers' compensation by Washington's State Fund and were inspected by state safety inspectors and cited for violating the falls in construction standard in 1991–1992 (the "enforcement" group), and 2) a control group of State Fund construction employers that had not

been inspected and cited for violating the standard through December 31, 1992.

## Analysis

For the enforcement group, fall injury rates were calculated for the one-year period prior to the first inspection in 1991–92 where the standard was violated, and the one-year period following this inspection. In order to be included in the analysis, an employer must have been covered by the State Fund for both one-year periods (i.e., they must have reported the number of hours worked by their employees to the Department of Labor and Industries for all eight quarters).

A similar analysis was conducted for the control group. Fall injury rates were calculated for two one-year periods: Prior to and after October 1991 (the median date of inspection for the enforcement group). To be included in the analysis, employers must have been insured by the State Fund for the entire two-year period, as above.

Claim rates were calculated for the “before” and “after” periods for the two groups. Matched analyses using Wilcoxon signed rank tests were used to determine statistically significant changes in claim rates over time. Logistic regression was used to examine the relationship between enforcement and reduction in fall injury rates over time (expressed dichotomously), while controlling for employer size and business type (Standard Industrial Classification).

## RESULTS

Over the 1991–1992 period, 28,613 construction employers were insured by Washington’s State Fund; of these, 1,609 were visited by state plan safety inspectors and cited for violating the falls in construction standard during the same period. Of these, 784 employers (49% of those cited) had complete information for the two one-year periods prior to and after their inspection dates. Reasons for the inspections included programmed (scheduled) evaluations (83.2%), employee complaints (8.2%), referral (1.8%), inspection of a fatality or accident (0.8%), and other unscheduled evaluations (5.9%). The median date of inspection was October 1991. The mean number of employees per company in the enforcement group was 22 (range 1–542).

A total of 28,006 construction employers were identified as potential control companies (that were insured by Washington’s State Fund over the October 1990 to December 1992 period that had not been cited for violation of the fall protection standard through December 31, 1992). Of these, 8,301 (30% of potential controls) had complete information for the two one-year periods of interest. The mean number of employees per company for the control group was seven (range 1–404).

Table I shows proportions of enforcement and control employers by industrial category. Enforcement employers were more likely than control employers to be engaged in nonresidential construction, and roofing, siding, and sheet-metal work. Enforcement employers were less likely than controls to be classified as plumbing, heating and air conditioning, electrical, or concrete work contractors. The distribution of control employers by industrial category was similar to that for all State Fund construction companies.

A total of 313 compensable fall injury claims were accepted in the period before inspection for the enforcement group; 269 were accepted during the period after inspection (Table II). The mean individual difference between the “before” and “after” rates was 1.02 per 200,000 hours worked, with a standard deviation of 14.04; this difference did not statistically differ from zero ( $p = .081$ ). Overall, the grouped injury rate after inspection (1.39 per 200,000 hours) was less than the rate for the period before inspection (1.78 per 200,000 hours).

A second analysis was conducted that included only employers whose inspections were carried out because they were scheduled by the Department of Labor and Industries (that is, excluding inspections carried out because of injuries, fatality or accident occurrences, or complaints). For these 653 employers, results were similar to those for the full group of 784 cited employers: The mean individual difference between the before and after rates was 1.55 with a standard deviation of 13.77; the grouped claim rate after inspection (1.35 per 200,000 hours) was statistically significantly lower than the rate before inspection (1.83 per 200,000 hours worked) ( $p = .021$ ).

For the control group, a total of 590 fall injury claims were accepted during the one-year period prior to October 1991; 548 fall claims were accepted over the one-year period after that date (Table II). The mean individual difference between the before and after rates was 0.031, with a standard deviation of 16.85. Grouped claim rates for the two periods did not statistically significantly differ (1.04 per 200,000 hours worked before the midpoint date and 0.95 per 200,000 hours after the midpoint date) ( $p = 0.93$ ).

In multivariate logistic regression analyses, the enforcement group was 2.3 times as likely to experience a reduction in injury claim rates (before to after inspection) as control employers ( $p < 0.0001$ ) after adjustment for employer size and type of business. Table III shows the types of falls which injured individuals in the enforcement and control groups. Falls from ladders and other falls to lower levels were the most frequent types of compensable fall injuries for both groups.

## DISCUSSION

Effectiveness of safety standards might be measured in any number of ways, including change in employer safety practices, number of deaths or injuries prevented, or savings

**TABLE I.** Comparison of Washington Construction Employers That Were Cited for Violating the Fall Protection Standard (1991–1992) to Those That Were Not Cited, by Industry Type

SIC code <sup>1</sup>	Description	n = 28,613		
		n = 784 Cited employers <sup>2</sup> %	n = 8,301 Employers not cited <sup>2</sup> %	All state fund construction companies <sup>3</sup> %
152	Residential building construction	33.7	28.9	31.8
153	Operative builders	1.3	1.3	0.7
154	Nonresidential building construction	12.2	3.8	3.3
161	Highway and street construction	0.8	1.4	1.3
162	Heavy construction, except highway	3.4	6.1	5.2
171	Plumbing, heating and air conditioning	4.3	11.4	8.1
172	Painting and paper hanging	2.6	4.7	6.3
173	Electrical work	4.1	10.6	6.8
174	Masonry, stonework, and plastering	7.7	7.4	7.1
175	Carpentry and floor work	3.2	6.1	10.6
176	Roofing, siding, and sheet-metal work	18.8	3.1	4.2
177	Concrete work	1.5	5.1	5.2
178	Water well drilling	—	0.5	0.2
179	Miscellaneous special trade contractors	6.3	9.6	9.1
	Total	99.9	100	99.9

<sup>1</sup>Standard Industrial Classification.

<sup>2</sup>State Fund construction employers that submitted employment hours for all eight quarters of the 1991–1992 study period.

<sup>3</sup>State Fund construction employers that submitted any employment hours to the Department of Labor and Industries in 1991–1992.

**TABLE II.** Washington State Fund Workers’ Compensation Claims for Construction Employers: A Comparison of Fall Injury Rates for Employers That Were Cited for Violating the Falls in Construction Standard and Employers That Were Not Cited

	Cited employers	Employers not cited
No. of employers	784	8,301
One-year period before inspection (or before October 1991, for non-cited employers):		
No. of fall injury claims	313	590
Fall injury rate/200,000 hours worked	1.78	1.04
One-year period after inspection (or after October 1991, for non-cited employers):		
No. of fall injury claims	269	548
Fall injury rate/200,000 hours worked	1.39	0.95
Mean individual difference per employer between “before” and “after” rate (standard deviation)	1.02 (14.04)	0.031 (16.85)
P-value*	0.081	0.93

\*Wilcoxon signed rank test comparing “before” and “after” claim rates.

**TABLE III.** Washington State Fund Workers’ Compensation Claims for Construction Employers: Types of Fall Injuries

	Cited employers no. (%)	Employers not cited no. (%)
Total no. compensable fall claims	582	1,138
Type of fall		
Fall from elevation	9 (1.5)	31 (2.7)
Fall from platform	54 (9.3)	131 (11.5)
Fall from ladder	172 (29.6)	382 (33.6)
Fall from piled matter	1 (0.2)	3 (0.3)
Fall on stairs	36 (6.2)	99 (8.7)
Fall into openings	45 (7.7)	94 (8.3)
Fall from roof	107 (18.4)	104 (9.1)
Fall to lower level	158 (27.1)	294 (25.8)

in injury-related costs (over costs of compliance measures). There are many potential difficulties in attempting to conduct such an analysis of regulatory effectiveness. First, many employers are not aware of workplace health and safety regulations, even when standards are specific to their industries. Changes in safety practices cannot be expected if employers are not aware of their responsibilities. Second, employers that are aware of health and safety regulations

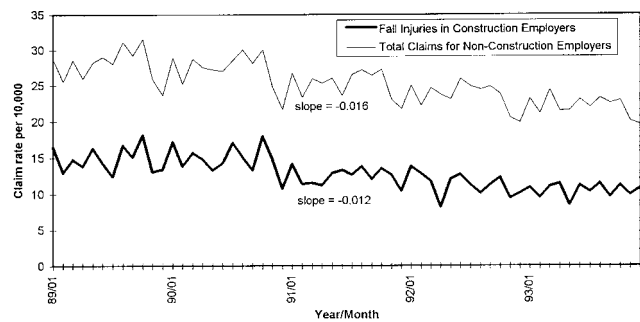
may not comply with them because the regulatory requirements may be difficult to understand, implement, or carry out on an on-going basis, or are perceived as too costly. Since the likelihood of compliance inspection is relatively small, some employers may consider the risk (and cost) of inspection and citation to be less than the burden of implementing workplace safety measures. In any case, it is often not possible to accurately assess changes that are made in individual workplaces. Third, costs and benefits of interventions may not be quantifiable; employers might also consider the risk and cost of employee injuries to be less than the costs of regulatory compliance. Last, injury/illness events may be difficult to measure because they are not recognized, reported, or recorded as work-related.

Nevertheless, some evidence suggests that OSHA regulations have been effective, particularly in reducing injuries. Since enactment of the OSH Act in 1970, U.S. occupational fatality rates have steadily decreased from 17.2 per 100,000 workers in 1972 to 7.7 per 100,000 in 1993 [U.S. Congress Office of Technology Assessment, 1995]. More specifically, there were approximately 60% fewer deaths from dust-related fires and explosions in grain-handling industries after OSHA's 1987 standard that addressed these hazards. There were approximately 35% fewer deaths from trench cave-ins after the agency's 1989 standard addressing excavation practices in the construction industry [U.S. Congress Office of Technology Assessment, 1995]. Overall, nonfatal injury and illness rates also decreased from 10.9 per 100 workers in 1972 to 8.5 per 100 in 1993 [U.S. Congress Office of Technology Assessment, 1995].

A few investigators have attempted to assess the effectiveness of regulatory enforcement in specific workplaces. A study carried out in Oregon indicated that employers that received comprehensive safety consultations from the Oregon Occupational Safety and Health Division in 1992 showed an 85.5% reduction in citable hazards upon subsequent compliance inspection [Oregon Department of Consumer and Business Services, 1994]. Moreover, the number of disabling injuries occurring in these 107 workplaces fell approximately 18% in the two years following the consultation visit [Oregon Department of Consumer and Business Services, 1995].

In a study of 6,842 manufacturing plants, Gray and Scholz [1993] found a 22% decline in injury rates after employers were inspected by OSHA. However, the authors pointed out that although injuries decreased after plants were inspected, the overall effect of enforcement is small because only a small proportion of employers are inspected by OSHA.

The authors discussed the concept of "deterrence," where OSHA inspections make employers less likely to violate OSHA standards because violations will be detected and penalized. Deterrence can be either general (likelihood



**FIGURE 1.** Washington State Fund Workers' Compensation Claim Rates 1989–93: Fall Injuries in Construction Employers Versus Total Claims in Non-construction Employers.

of inspection of any employer in an industry deters all employers in the industry) or specific (employers respond only if their own company is likely to be inspected). As Gray and Scholz's study examined injury rates in companies that had been inspected, their findings supported the theory of specific deterrence.

Our previous work suggested that simply promulgating a standard, combined with an extensive education campaign, did not appear to be effective in reducing fall injuries in Washington construction companies. An analysis of workers' compensation claims for compensable fall injuries in construction companies showed that, although fall injury claim rates decreased over the 1989–1993 period (with a regression slope of  $-0.012$ ), the decline was actually statistically significantly less than the decline for total compensable claims in all other industries combined (with a slope of  $-0.016$ ) (Fig. 1). The slope for the decline in construction fall injury rates did not significantly differ before and after enactment of the fall protection standard. This suggests that enactment of an industry-specific fall protection standard did not have an industry-wide effect on fall-related injuries. However, this may have occurred because some employers were not aware of the standard (despite the agency's efforts to notify and educate construction employers), or because they were unwilling or unable to implement the requirements of the standard.

In the current study, we identified a group of employers who became aware of the standard at the time of their inspection, if not before. Of course, this likely represents only a small proportion of employers aware of the standard. A broader definition might include all employers who were sent educational materials by the Department of Labor and Industries or who participated in agency workshops on the standard. Unfortunately, it was not possible to determine which employers these were and link them to the administrative database of workers' compensation claims data. Another study group that was considered included employers that had been inspected by state OSHA inspectors for any reason,

regardless of whether they were in violation of any standards. This definition was rejected for two reasons: First, inspectors may not have discussed fall protection with employers when their visit was conducted. Second, inspections may result in no citations for many reasons, including persistent appeal on the part of employers so that citations are eventually dropped by the agency. Thus, the group of employers that were inspected but not cited for violating the fall protection standard were not included in the study group because their awareness status was unclear.

Similar to findings by Gray and Scholz [1993], our results suggested that specific deterrence is effective: For the 784 construction employers cited for violating the fall protection standard in the 1991–1992 period, the workers' compensation claim rate for fall injuries resulting in four or more days of lost time from work decreased from 1.78 to 1.39 per 200,000 hours worked for the one-year periods before and after inspection. For the control group, the claim rate decrease was less marked, from 1.04 to 0.95 per 200,000 hours. These results suggest that regulatory enforcement of the fall protection standard may have been related to a reduction in fall injuries in Washington construction companies that were cited, at least for the one-year period after inspection. Further studies will be necessary to determine if this effect persists over time.

However, it is not clear that regulatory enforcement, *per se*, was the most important factor (if any) that caused employers to improve health and safety awareness and prevention activities. It may have been the education and training components of the inspections that were most helpful. The Oregon studies described above support this hypothesis, as hazard and injury reductions were observed after OSHA consultation visits, which are not punitive but, rather, emphasize education and training [Oregon Department of Consumer and Business Services, 1994; Oregon Department of Consumer and Business Services, 1995].

It should be pointed out that workers' compensation data represent an underestimate of the true prevalence of injuries and illness in the working population [Baker et al, 1988]. In this study, only compensable claims were selected for analysis; because these are relatively more severe injuries, it was thought that underreporting problems would be less likely than for all fall injury claims combined.

Construction companies included in this study were limited to those insured for workers' compensation by Washington's State Fund. State Fund employers employ approximately two-thirds of Washington workers; however, they do not include Washington's largest companies, which self-insure for workers' compensation coverage. However, over two-thirds of State Fund construction employers were excluded because they did not submit employee work hours for the full eight quarters selected for study. The companies that qualified for inclusion (784 enforcement employers and

8,301 control companies) were somewhat larger than all State Fund construction companies as a whole, with an average of eight and three employees, respectively. Thus, companies included in the study appeared to represent, with respect to size, the mid-range of all state construction employers. Company size has an important relationship with likelihood of injury: studies have consistently shown that smaller-size construction employers have higher injury rates [Ringen et al, 1995].

It was apparent that enforcement and control employers differed somewhat in terms of size and construction specialties. Enforcement employers had more employees and were more likely than control employers to be engaged in nonresidential construction, and roofing, siding, and sheet-metal work. Enforcement employers were less likely than controls to be classified as plumbing, heating and air conditioning, electrical, or concrete work contractors. It was evident that the control group had lower overall compensable claim rates than the enforcement group. An explanation for both of these differences may relate to likelihood of inspection: Smaller companies are less likely to be inspected by Washington's state OSHA plan [Kleinman and Cant, 1978]. It is also possible that inspectors are more likely to target employers they suspect have greater fall hazards (such as roofing contractors). However, the relationship between enforcement and a reduction in claim rates persisted after adjusting for employer size and construction specialty (OR = 2.3,  $p < 0.0001$ ).

In conclusion, the rate for workers' compensation claims for fall injuries decreased after construction employers were cited for violating the fall protection standard. The injury rate reduction was greater for employers that were cited for violating the standard than for employers that had not been cited. Over the 1991–1992 period, approximately 6% of Washington State Fund construction employers were cited for violating the standard. If the reduction in injuries was causally related to enforcement of the standard, results of this study suggest that, if more employers were inspected, industry-wide fall injury rates might be expected to decrease.

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