Effectiveness of the HomeSafe Pilot Program in Reducing Injury Rates Among Residential Construction Workers, 1994–1998

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Background *The construction industry typically has one of the highest fatal and non-fatal injury rates compared with other industries. Residential construction workers are at particular risk of injury (work is in remote sites with small crews, there are often many subcontractors, and they have limited access to safety programs). Difficulty accessing information specific to this group has made research more challenging, therefore, there are few studies. This study evaluated the effectiveness of the HomeSafe Pilot Program, a safety education and training program designed to reduce injuries among residential construction workers.*

Methods *Researchers evaluated whether overall and severe injury incidence rates declined during the intervention period. Data were analyzed using incidence rates and Poisson regression to control for the effect of antecedent secular trend.*

Results *Injury incidence rates declined significantly following HomeSafe; however, this effect was not statistically significant once temporal variation was controlled.*

Conclusions *The decline in injury rates following HomeSafe cannot be attributed solely to HomeSafe, however, programmatic and methodologic limitations contributed to the inconclusive results. Further research into the hazards faced by residential construction workers is needed.* Am. J. Ind. Med. 45:210–217, 2004. *© 2004 Wiley-Liss, Inc.*

KEY WORDS: residential construction; occupational safety; injury prevention; program evaluation

INTRODUCTION

Occupational injury is a major threat to public health. The construction industry typically has one of the highest fatal and non-fatal injury rates compared with other industries, and in 1994 it had the third highest fatality rate by major industrial category at 15 per 100,000 full time workers [Bureau of Labor Statistics, 1995a]. The non-fatal injury rate for the same year was 11.5 per 100 full time workers, ranging from 9.5 (water well drilling) to 17.2 (roofing, siding, and sheet metal work) per 100 full time workers. These rates include both commercial and residential construction workers involved in all trades. Rates for residential construction workers in particular are more difficult to access. The Bureau

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of Labor Statistics (BLS) data are the primary sources of data on construction injuries but are reported by Standard Industrial Classification (SIC) code. SIC codes do not differentiate between residential trades and commercial trades, with the exception of residential builders (1521 and 1522). In the United States, the non-fatal injury incidence in 1995 among residential builders was 8.5 and among non-residential builders was 10.9 per 100 full time workers [Bureau of Labor Statistics, 1995b]. Construction trades, however, cannot be identified as specifically residential through BLS data, and must be identified through other means, generally by state rather than national level data.

In a study of residential construction workers in North Carolina, Dement and Lipscomb [1999] examined workers' compensation claims provided by the North Carolina Homebuilders Association. For 1994, they found an overall incidence rate for medical or lost time injuries among all trades of 10.97 per 200,000 person hr worked. Dement and Lipscomb reported that, in 1992, North Carolina construction workers experienced an injury incidence rate of 11.7, residential construction workers experienced a rate of 13.1, and their sample experienced a rate of 14.5 per 200,000 person hr worked [North Carolina Department of Labor, 1994; Dement and Lipscomb, 1999]. Lipscomb et al. [1995] also reported rates based on workers compensation claims among Washington State residential carpenters. For those claims involving 8 or more days away from work, the rate was 15.4 per 200,000 hr as opposed to a rate of 5.8 among North Carolina carpenters. Residential drywall workers in Washington State also had higher rates of LWDIs than their North Carolina counterparts (11.9 compared to 4.8, respectively).

In Colorado, between 1980 and 1989, the average annual construction fatality rate was 28.5 per 100,000 workers, one of the highest in the country [Bureau of Labor Statistics, 1997; NIOSH, 1997]. Forty-three construction workers died between 1992 and 1993, and in 1997, Colorado had 25 construction industry fatalities [Division of Worker's Compensation, 1995; Bureau of Labor Statistics, 1997]. Following the deaths of the seven workers in 1991, the Home Builder's Association (HBA) of Metropolitan Denver and the Occupational Safety and Health Administration, Region VIII (OSHA) began a collaborative effort to develop an intervention program to address the specific hazards and safety challenges faced by the residential construction industry.

There is limited research demonstrating the utility of safety training for the reduction of injury rates in construction. Kinn [2000] found that safety orientation was associated with a 77% reduction in injuries among plumbers and pipefitters. They also found that of those workers injured, 38% did not receive any health and safety training or orientation [Kinn, 2000].

Intervention programs and research studies in residential construction are difficult to implement and monitor because of industry specific characteristics. These include a transitional workforce employed by small businesses with sporadic work patterns, short term employment opportunities, and multi-employer, temporary, and/or isolated work sites [Ringen et al., 1995; Ringen and Stafford, 1996; Lipscomb et al., 2000]. In an effort to overcome these challenges and provide a comprehensive and effective intervention program, the creators of the HomeSafe Pilot Program provided safety training that was accessible, involved management in the program, and addressed hazards specific to residential construction.

HomeSafe Program

The HomeSafe Pilot Program is described in detail elsewhere [Gilkey et al., 1998]. It consists of a 3 hr safety training and program orientation class, a "Guide to Safe Work Practices for Home Builders: HomeSafe 10 Point List" pocket-sized booklet, and access to optional OSHA Training Institute-approved 10 hr Construction Courses, tailored to the particular needs of residential construction workers. In return for participation in the HomeSafe Program, companies received focused inspections on the contents of the 10 points in the HomeSafe booklet from OSHA compliance officers, thus limiting citations for non-serious violations. In addition, if a HomeSafe company was cited, it was eligible to receive the maximum penalty reductions available. Participating companies also were eligible for the Colorado Cost Containment program, which reduces workers' compensation premiums by 5%, and for an additional 5% reduction in workers' compensation premiums through a major carrier in the Denver Metropolitan area.

The purpose of this study was to evaluate the effectiveness of the HomeSafe Project in reducing both overall and severe injuries among residential construction workers, during the years 1994–1998.

MATERIALS AND METHODS

Injury Data Collection

Members of HomeSafe submitted the following information to the local HBA: OSHA 200 logs, first reports of injury, and workers' compensation loss runs for calendar years 1994–1998. Those companies with fewer than 10 employees filled out forms similar to the OSHA 200 forms provided by HomeSafe staff. The HBA forwarded this information, assigning each company a four-digit code, to the HomeSafe research staff. Injuries were cross-referenced between all three data sources for accuracy, and incomplete or incompatible reports were excluded. Illnesses were not included in the analysis, and those reports also were excluded. Injury information was coded for number of injuries per year and severity. Severity was coded as a dichotomous variable and defined as an injury that results in at least one lost workday. The day of injury was not included as a lost workday.

Population Denominator

Each company was required to submit the total person hours worked for each year of the study. These were used as the denominator for the rate calculations. Any company who did not submit total hours was not included in the rate analysis. Rates for each year and then all years were calculated.

All injury events were included in the calculations and the time accumulated in the denominator included the total hours worked per year for each employee and did not cease with the first injury occurrence. Most employees will return to work following an injury and will be at risk of injury again, hence their continuous inclusion in the denominator. Pre-HomeSafe was defined as January 1, 1994 through the company's compliance training date. Pre-HomeSafe includes all injuries reported during the years 1994–1996. Injuries occurring before a company's training in 1997 also were defined as pre-HomeSafe. Post-HomeSafe was defined as the company's compliance training date through December 31, 1998. Injuries occurring after the company's compliance training and in 1998 were included as post-HomeSafe injuries. Compliance trainings occurred each month beginning in January 1997. Some participating companies began implementing HomeSafe as early as February 1997 and some did not begin until, e.g., December 1997.

Statistical Analysis

Injury incidence rate calculations

Annual crude incidence rates were calculated by year, 1994–1998, for participating HomeSafe companies. Pre- and post-HomeSafe incidence rates were calculated per 200,000 hr worked for the following types of injuries: all injury cases, cases with lost work time, and lost work time cases incurring medical costs. Numerator data included all documented injuries and denominator data included the total hours worked reported by each company annually. In addition, 95% confidence intervals were calculated for each rate.

Lost workday injury (LWDI)

For the purposes of this paper, all injuries resulting in one or more days away from work were considered LWDIs, whether or not the lost time was paid or not paid. LWDIs served as a surrogate for injury severity, in that an injury resulting in one or more days away from work was considered to be more severe than an injury resulting in no days away from work [Dement and Lipscomb, 1999].

The study involved the comparison of pre-intervention injury incidence rates (1994–1997) and post-intervention injury incidence rates (1997–1998). Overall injury incidence rates were compared, as were LWDI incidence rates. Injury incidence rates for all injuries and for LWDIs were calculated for each calendar year for each participating company and for the pre- and post-intervention years.

In addition, to control for the potentially confounding effect of annual trend when comparing the pre- and post-intervention rates, the quasi-likelihood, over-dispersed Poisson regression analysis was used. Poisson regression models allow the regression parameters to be interpreted as the log of the relative risk, adjusted for other covariates in the model [Davidson et al., 1994]. In this study, annual trends in injury incidence rates were considered as potentially confounding covariate. The primary purpose of the Poisson regression was to control for the effect of antecedent time trend on decreasing injury incidence rates. The use of the Poisson model to evaluate program effectiveness through the analysis of incidence rates was successfully employed by Kuhn et al. [1994] in their evaluation of a community based injury prevention program aimed at reducing injuries among urban children (Davidson et al., 1994; Kuhn et al., 1994). They assert the value of this method is its ability to quantify time trends and, therefore, describe and evaluate the effect of temporal variation. This method can explain outcomes due to the effect of time versus the effect of the intervention, and is appropriate for the analysis of rare events.

The Poisson model adjusted for the time variable in order to evaluate the relative risk of injury during the pre-intervention period as compared to the post-intervention period. In other words, if injury incidence rates were decreasing before the intervention, the regression model would only indicate a protective effect of the intervention if a post-intervention decrease in incidence rates was greater than the pre-intervention trend.

The outcome variable was the injury rate for each year of the study and HomeSafe intervention was coded as an indicator variable, zero for pre-HomeSafe and one for post-HomeSafe. A general model was created, as well as a model for each trade group, for both LWDI and overall injuries. When the analysis was limited by LWDI, the data became more spare and convergence harder to achieve. Scale parameters were adjusted on all models to control for over-dispersion, based on the null model's Pearson chi-square ($P < 0.0001$ for all models, indicating extra-variation). Descriptive statistics and the Poisson regression analyses were done using SAS Institute [2000].

TABLE I. Residential Construction Trade Group and SIC in the HomeSafe Program; Colorado

Trade	Average firm size by trade	Number of employers in each trade	SIC
Landscaping	2	1	0781
Single family home builders	5	41	1521
Plumbing, heating, air conditioning	20	4	1711
Painting and paper hanging	24	3	1721
Electrical work	18	6	1731
Masonry and other stonework	28	2	1741
Plastering, drywall, and insulation	52	7	1742
Carpentry	15	11	1751
Floor laying and floor work	21	2	1752
Roofing, siding, and sheet metal work	8	7	1761
Concrete work	50	4	1771
Excavation work	10	3	1794
Miscellaneous special trade contractors	35	6	1799

RESULTS

Data from 97 companies were included in the analysis. Company trade was identified by SIC code and those trades are outlined in Table I. Companies ranged in size from sole proprietorships to over 100 employees, though most companies had fewer than 50 employees. Companies reported a total of 23,620,963 hr worked during 1994–1998.

Overall Injuries

A total of 1,517 injuries were reported during the 3 pre-HomeSafe years and 493 were reported during the 2 post-HomeSafe years. Among those employees who were injured, 98% were men and 2% were women. They ranged in age from 17 to 70, with most in their late twenties to late thirties, and ranged from 0 years to 37 years of experience, with most employees possessing 1–6 years of experience.

Five companies did not report total person hours worked for 1994–1996; therefore, injuries occurring in those companies were not included in the rate calculations. A total of 1,478 injuries and 16,946,918 hr pre-HomeSafe and 493 injuries and 6,706,046 hr post-HomeSafe were used in the analysis of overall crude rates. Overall rates were evaluated by year. Injury rates in 1997 were included in either a pre-HomeSafe period (labeled 1997) or a post-HomeSafe time period (labeled 1997; Fig. 1). A downward trend in injury rates was apparent from 1994 through 1997, with a high of 19.6 injuries per 200,000 in 1994 and a low of 14.3 injuries per 200,000 in 1997. However, post-HomeSafe rates in 1997 increased to 17.4 before dropping again in 1998 to 12.9 per 200,000 person hr worked. These rates represent all trades, including general contractors and builders. Descriptive analysis of injury incidence rates indicated a significant difference in overall injury incidence rates pre-HomeSafe and

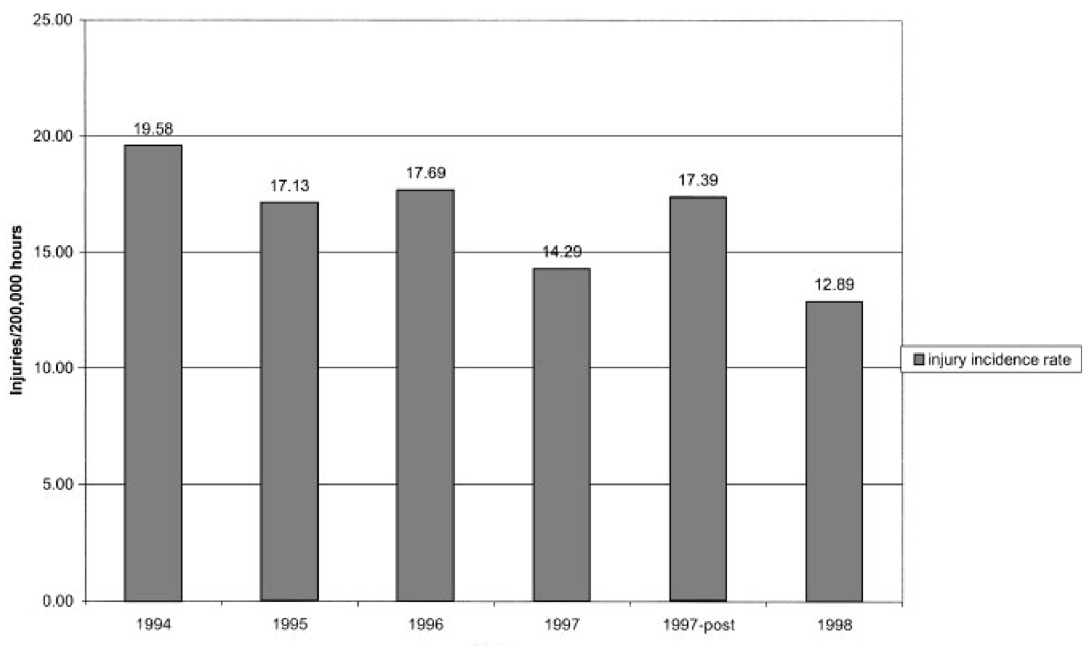

FIGURE 1. Injury incidence rates per 200,000 hr among residential construction workers, Colorado.

TABLE II. Injury Rates Among HomeSafe Partners in the HomeSafe Program, Colorado, Pre- and Post-HomeSafe, per 200,000 hr

	Overall	LWDI	LWDI and medical cost
Pre-HomeSafe	17.4 (16.5, 18.3)*	5.8 (5.3, 6.3)	3.8 (3.3, 4.3)
Post-HomeSafe	14.7 (13.4, 15.9)	3.5 (2.8, 4.0)	2.2 (1.5, 3.0)

*95% Confidence intervals.

TABLE III. Results of Poisson Regression Models for Adjusted Rates of Overall and LWDIs among Residential Construction Workers in the HomeSafe Program; Colorado*

Injuries	β	SE(β)	*P*	RR	95% Confidence interval
Overall					
Year	−0.1015	0.1141	0.3736		
Intervention	−0.0356	0.3615	0.9215	0.97	0.5, 2.0
LWDI					
Year	−0.1337	0.1261	0.2890		
Intervention	0.0213	0.4078	0.9583	1.02	0.5, 2.3

*Effect of intervention period adjusting for year.

post-HomeSafe, with rates dropping from 17.4 injuries per 200,000 hr worked to 14.7 per 200,000 hr worked (Table II).

The Poisson regression results in Table III, however, show no decrease in overall injury incidence rates following the HomeSafe intervention (RR = 0.97, 95% CI = 0.5, 2.0). Interestingly, the results also indicate no significant time trend was associated with the decrease in injury rates.

LWDI

In addition to overall incidence rates, rates were calculated for injuries resulting in lost work time. A total of 63 companies representing 472 LWDIs (1,387 total injuries) and 16,249,058 hr pre-HomeSafe and 47 companies representing 117 LWDIs (438 total injuries) and 6,691,218 hr post-HomeSafe were included in the rate calculations. Lost work time injury rates for the years 1994–1998 are presented in Figure 2. A downward trend is evident, indicating a decrease in the rate of severe injuries over time. Analysis of injury incidence rates revealed a significant decrease in LWDI incidence rates (5.8 per 200,000 hr worked pre-HomeSafe to 3.5 per 200,000 hr worked post-HomeSafe) and a significant decrease in LWDI associated with medical cost (Table II).

The Poisson model for LWDI essentially mimics the overall model (Table III). No statistically significant results emerged from the data, overall model: RR = 1.0, 95% CI = 0.5, 2.3). This is consistent with the graphical represen-

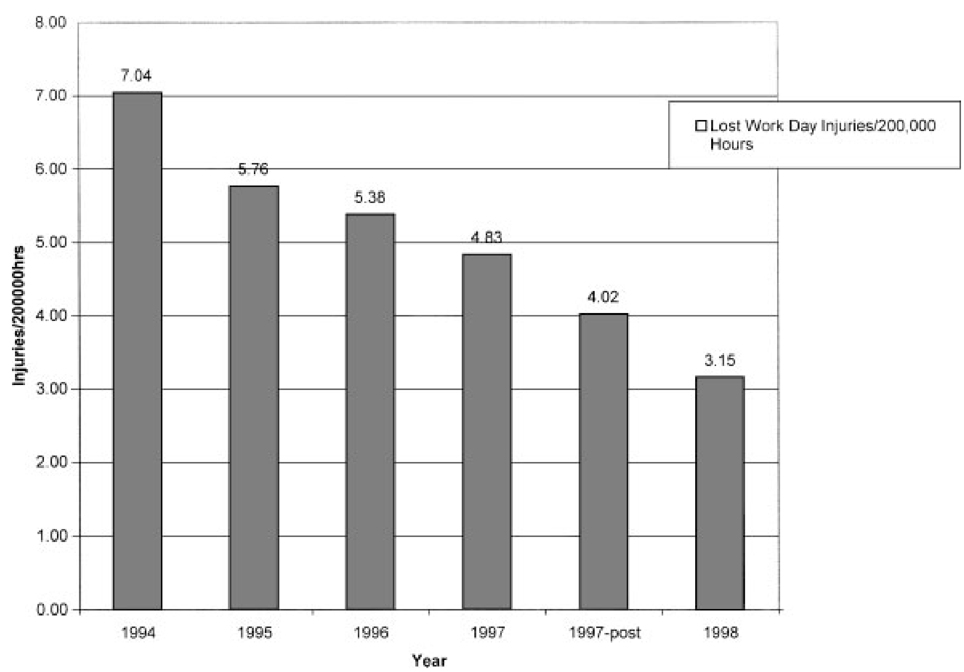

FIGURE 2. Lost work day injuries (LWDIs) per 200,000 hr among residential construction workers, Colorado.

tation of LWDI rates: a downward trend is visible from 1994 to 1998, with no obvious change following HomeSafe intervention (though annual trend was not a significant contribution to the overall model; Fig. 2).

DISCUSSION

The results of the analysis in this study yielded inconclusive information about the effect of the HomeSafe Pilot Project on injury incidence rates. While the incident rate comparison indicated an overall (and statistically significant) decrease in injury rates following HomeSafe, an effect of HomeSafe on all trades combined was not apparent in the regression model. For the LWDIs especially, injury rates were decreasing before HomeSafe and continued following HomeSafe, with no change in that trend attributable to the intervention.

The lack of statistically significant findings in the presence of an overall effect could be explained by methodological limitations. The study itself was limited to a 12–24 month follow-up period. This limited period may not have provided adequate time for intervention effects to be seen.

A number of threats to internal validity were evident. The HomeSafe participants were not randomly selected, they were recruited by the HBA. As described previously, a number of incentives were used to recruit these companies, which introduces the potential for self-selection bias. If companies joined the program for the benefits and did not implement the program, we would expect to see a bias toward the null hypothesis, or bias toward no effect.

In addition, the study must contend with information bias. Non-differential misclassification of exposure almost certainly occurred. Exposure to HomeSafe intervention was determined by company participation and was dated according to company compliance training, not employee participation. Some employees may have been exposed to HomeSafe prior to the intervention start date through companies who participated in the development of HomeSafe. Even the exclusion of those companies could not rule out this exposure secondary to the lack of individual data and the frequency with which employees changed employers. Following the intervention, all injured employees were considered ‘exposed’ because of the employer. However, some companies may not have implemented the program, or the employee may have never been exposed to the program. Again, this would bias our results toward the null. Without adequate individual measurement of the exposure, the effects of the program are difficult to assess.

The lack of a comparison group also makes inferences about the success of the program difficult. Efforts to recruit a control group were unsuccessful and comparisons with BLS data are inadequate as they include commercial construction workers and represent a sample of States, not including Colorado. While we know our participants experienced a decrease in rates following HomeSafe, we do not have information about the experiences of other residential construction companies in Colorado. For example, HomeSafe partners could have been experiencing a greater decrease in injury rates than other companies in the region.

There are other explanations for the inconclusive effects of this intervention, including both behavioral explanations and program limitations. First, the design and approach of the HomeSafe Pilot Program had a number of significant limitations. Though the design of HomeSafe included administrative, behavioral, and education-based interventions, there was no evaluation of the level of readiness for change among this population. Research in the psychological and communication sciences has demonstrated the importance of directing prevention activities at the level of awareness and motivation to change of the individual, group, or community [Prochaska et al., 1992; Edwards et al., 2000]. Individuals who designed and implemented HomeSafe (business owners, managers, and superintendents) may have had a different view of or motivation for introducing interventions designed to bring about a change in safety behavior than the tradesmen, apprentices, and laborers.

In addition, though the HomeSafe Pilot Program was designed to address the industry characteristics that interfere with health and safety education and training, problems with information dissemination remained. The HomeSafe Program had no mechanism to ensure dissemination among the workers. Information was provided to company representatives with the understanding that they would then train their employees. There were companies who sent safety personnel, superintendents, managers, and owners to the 3 hr training, received booklets, stickers, and posters, and when contacted 1–2 years later, had no memory of HomeSafe or enrolling in HomeSafe. Employees need access to committed supervisors, managers, and safety personnel for ongoing safety training, problem solving, and hazard assessment in order to continue their behavior change and personal investment in safety [Bullock, 1988].

Additionally, workers in residential construction often switch employers based on work load and experience sporadic work patterns, thus limiting their exposure to health and safety information. Ringen et al. [1995] reported that many hazardous exposures in the construction industry are due to poor access to information. Kinn [2000] reported that 58% of injured workers in the study did not have appropriate safety education and training. Companies often subcontract trade specialties and may not train those subcontractors using the HomeSafe model, or may not provide health and safety training secondary to economic impracticality and the time constraints of short term assignments [Kinn, 2000]. The likelihood that each employee received the information is small.

Strengths of HomeSafe

The program did, however, have some significant strengths and benefits aside from its role in injury prevention. The HomeSafe Program attempted to make safety information specific to residential construction visible and available to most workers. Not only were participating companies provided with pocket-sized booklets for widespread distribution, they were provided with hard hat stickers and posters. In this way, HomeSafe information was provided in a variety of highly accessible, visible and potentially interesting formats, thus increasing the chance of worker exposure to the information. This method of increasing the salience of the information has been researched and reported as useful in both health and advertising campaigns, especially when the recipient of the information may not be actively engaged or interested in the process of behavior change [Slater, 1999].

Additionally, the HomeSafe project actively involved the HBA in safety promotion, brought together safety personnel from a number of different and competing companies, and provided the means for the HBA and OSHA to work together for a common goal. The HBA safety committee met regularly, discussed current safety issues, and performed regular jobsite safety audits. Representatives from OSHA attended safety meetings and received updates on the status of the program.

Finally, overall injury rates did decrease following HomeSafe, and the limitations described above may have prevented discovery of the true effects of the program.

Conclusions and Recommendations for Further Research

Injury incidence rates decreased for both overall injuries and LWDIs pre-HomeSafe versus post-HomeSafe. The regression analyses indicated this decline was not significant once the secular effect of time is accounted for. However, optimism regarding an intervention such as HomeSafe is warranted, based on the presence of declining injury incidence rates, especially injury rates for severe injuries. Methodologic problems with the HomeSafe Program indicate the need for more carefully crafted interventions with evaluation plans integrated into the program from the start. Emphasis on the dissemination of information to the workers, methods for monitoring the extent of the dissemination, and, therefore, the exposure, and methods for obtaining a control group would have improved the validity of the findings of this study, as would access to information at an individual, not company, level. These recommendations should be coupled with interventions that are based on sound data regarding the experiences of workers in this industry and the community or social culture surrounding on-the-job injuries. The specific characteristics of the residential construction industry indicate the need for more research into the hazards, perceptions, and behaviors of workers in this industry.

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