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Vicki Kaskutas
Washington University School of Medicine in St. Louis

Skye Buckner-Petty
Washington University School of Medicine in St. Louis

Ann Marie Dale
Washington University School of Medicine in St. Louis

John Gaal
Carpenters District Council of Greater St. Louis and Vicinity

Bradley A. Evanoff
Washington University School of Medicine in St. Louis

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Vicki Kaskutas, OTD,[1,2] Skye Buckner-Petty, MPH,[2] Ann Marie Dale, PhD, OTR/L,[2] John Gaal, EdD,[3] Bradley A. Evanoff, MD, MPH[2]

Affiliations:
[1]Program in Occupational Therapy, Washington University School of Medicine, St. Louis, MO, USA
[2]Division of General Medical Sciences, Washington University School of Medicine, St. Louis, MO, USA
[3]Carpenters District Council of Greater St. Louis and Vicinity, St. Louis, MO, USA

This work was performed at the Washington University School of Medicine in St. Louis, MO.

Corresponding author:
Vicki Kaskutas
Washington University School of Medicine
Division of General Medical Sciences
Campus Box 8005
4523 Clayton Avenue
St. Louis, MO 63110

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Carpenters union and apprenticeship program and advised the study team during preparation of the manuscript. Drs. Kaskutas and Evanoff were the primary writers of this manuscript, with all other authors contributing to and editing portions of the manuscript. All authors reviewed the final manuscript. All authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

ABSTRACT

Background: This research aimed to improve residential construction foremen's communication skills and safety behaviors of their crewmembers when working at heights.

Methods: Eighty-four residential construction foremen participated in the 8-hour fall prevention and safety communication training. We compared pre-intervention surveys from foremen and their crewmembers to measure the effect of training.

Results: Foremen and crewmembers' ratings showed improvements in fall prevention knowledge, behaviors, and safety communication and were sustained 6-months post-training, with emphasized areas demonstrating larger increases. Ratings were similar between foremen and crewmembers, suggesting that the foremen effectively taught their crew and assigned accurate ratings. Based upon associations between safety behaviors and reported falls observed in prior research, we would expect a 16.6% decrease in the one year cumulative incidence of self-reported falls post-intervention.

Conclusions: This intervention improved safety knowledge and behaviors of a large number of workers by training construction foremen in fall prevention and safety communication skills.

Key Words: construction, safety communication, safety behavior, fall prevention, communication training

INTRODUCTION

The construction industry has more fatalities than any other employment sector in the US economy, with falls from heights accounting for over one-third of the fatalities (CPWR - The Center for Construction Research and Training, 2013). Over half of the fatal falls occur from structures that are less than 20 feet high (CPWR - The Center for Construction Research and Training, 2013). In residential construction and the framing industries, falls account for nearly all fatalities (Bureau of Labor Statistics, 2015). The non-residential sector saw a 4% decrease in fatalities in 2012, while residential construction worker fatalities increased 82% (CPWR - The Center for Construction Research and Training, 2013). Despite employing 41% of the construction workforce, 56% of the construction worker fatalities occurred in establishments employing less than 20 employees (CPWR - The Center for Construction Research and Training, 2013).

The risk of sustaining a non-fatal work injury requiring days away from work is 78 per 100 full-time equivalent in the construction industry (Dong, et al., 2014), and falls account for 20% of work days missed (CPWR - The Center for Construction Research and Training, 2013). In the residential sector, inexperienced workers often perform risky work at heights before they have been trained in safe work methods (Kaskutas, et al., 2009, Lipscomb, et al., 2008). Residential carpenter apprentices were twice as likely to fall at work as apprentices working commercial construction (Kaskutas, et al., 2010). Most residential construction contractors employ fewer than ten workers (CPWR - The Center for Construction Research and Training, 2013) and safety problems are more prevalent in smaller construction companies (Cheng, et al., 2010, Kines and Mikkelsen, 2003, Shalini, 2009); where onsite safety professionals are rare, safety programs are lacking (Choi and Carlson, 2014), and worksite training is often inadequate (Hung, et al., 2011).

Construction workers typically learn how to perform production and safety-related tasks from an experienced worker at an active construction site (Rogers, 2007); however the quality and quantity of mentorship can be affected by staffing ratios, productivity expectations, environmental distractions, and the experienced workers' ability to mentor (Lipscomb, et al., 2008). Hu and colleagues (2011) examined casual factors of construction worker falls in 121 peer-reviewed articles and found strong evidence that both contractor/managerial safety interventions and workers' training and education influenced fall risks and injuries. Construction foremen and seasoned workers are often expert home builders, but many foremen lack safety communication and teaching skills (Kaskutas, et al., 2013). Evidence suggests that training can improve construction foremen's safety communication (Hung, et al., 2011, Kines, et al., 2010, Smith, et al., 2008) and can improve construction workers' fall prevention knowledge and behaviors (Evanoff, et al., 2012). Interventions targeting residential construction are especially timely as the industry is expecting significant growth in new workers (CPWR - The Center for Construction Research and Training, 2013) while learning to comply with more stringent federal fall prevention safety standards (Occupational Health and Safety Administration, 2010).

The goal of this research was to develop, implement, and measure the effects of a construction foremen fall prevention and safety communication intervention targeting priorities identified through needs assessment. We predicted that training foremen to better recognize hazards and train their crewmembers will increase worksite training and effectiveness, increase workers' safety knowledge and safety behaviors when working at heights, improve perceptions of workplace safety culture, and improve overall worksite safety.

MATERIALS AND METHODS

This research occurred in collaboration with contractors, apprenticeship trainers, and members of the Carpenters' District Council of Greater St. Louis and Vicinity (CDC-StL). All procedures were approved and monitored by Washington University School of Medicine's Institutional Review Board.

Participants

Signatory contractors of the CDC-StL who perform residential construction were recruited by the researchers with assistance from the CDC-StL. After contractor consent was received, we invited front-line foremen, superintendents and company owners to participate. Crewmembers working for participating foremen completed surveys but did not participate in the training. Informed consent was obtained from all research participants.

Design

We compared results from participant and crewmember surveys and observational worksite audits performed prior to the intervention to those performed at 6-, 12-, and 24-weeks post-training. This design was intended to evaluate the effects of training and maintenance over time, corroborate foremen's self-reports, and measure knowledge transfer from the foremen to their crewmembers.

Measures

All measures were administered at the worksite by a retired journeyman carpenter who was trained as a research assistant. Crewmembers were approached by the research assistant and asked to complete a confidential written survey and return it in a sealed envelope. The survey measured crew behaviors when working on elevated surfaces, safety communication, safety climate, and one item measured fall prevention knowledge. This survey was used in prior fall prevention research (Kaskutas, et al., 2009) and was found to be sensitive to changes following a fall prevention training intervention with apprentice carpenters (Evanoff, et al., 2012). Most items between the foremen and crewmember surveys were similar to allow for comparison. Results from baseline assessments were shared with the participants during the training session.

Six items measured frequency of *fall prevention behaviors* on a 5-point scale (never, rarely, occasionally, often, and always) during step and extension ladder climbing, work from top plate of wall and floor joists, scaffold use, and personal fall arrest harness use. Crewmembers also indicated the percentage of time that they followed proper fall prevention safety. Similarly, foremen reported these measures for themselves and their crew.

Since the target of this fall prevention intervention was a change in safety behaviors rather than a change in knowledge, we included few safety knowledge questions. One item measured *fall prevention knowledge* when installing roof trusses safely, and related to changes in OSHA's requirements for the use of conventional of fall prevention that went into effect near the beginning of this project.

Safety climate was measured by ratings of agreement with 10 statements (8 for crewmembers) on a 4-point scale (strongly disagree, disagree, agree, or strongly agree). Four items came from Hahn and Murphy's Short Safety Climate Scale (2008), including "new workers learn quickly that they are expected to follow good health and safety practices," "workers are told when they do not follow good health and safety practices," "worker safety is a big priority with management", and "workers feel free to report safety violations". This scale is a valid and reliable measure of global safety climate (Hahn and Murphy, 2008)... Items from a scale used in previous construction research (Kaskutas, et al., 2009) measured construction-specific concerns, such as adequate time to be safe and productive, availability of fall arrest equipment, and familiarity with contractor's fall prevention plan. Internal consistency of this scale was 0.78 in our research with over 1,000 apprentice carpenters (Kaskutas, et al., 2009). Zohar's 10-item Group Safety Climate Survey (Zohar, 2000) was administered to crewmembers and foremen were administered 5 Zohar items that were appropriate for self-report. Since the Zohar survey refers to the employee's supervisor, we replaced the words "my supervisor" with "I" on the foremen's survey.

Safety communications were measured similarly on the participant and crewmember surveys. Formal communications focused on toolbox talks, short work task discussions that focus on safety, and informal communications focused on instructional session(s) with an experienced worker that may have a safety focus. Frequency of formal and informal communications was rated on a 5-point scale (every day, several times per week, several times per month, several times per year, and never). Methods of toolbox talk delivery were noted (workers sign a written talk, the talk is read aloud, the topic is discussed, hazards are identified, and the best way to perform upcoming work tasks is discussed), as well as perceived adequacy of the amount of day-to-day instruction (just right, not enough (need and want more), or too much). Respondents noted level of agreement on a 5-point scale for two training questions, "I only assign workers tasks which they have the skill, ability, and confidence to perform" and "I know the best way to teach each of my workers how to do unfamiliar work tasks." Foremen also reported how often they critically observe their worksites to identify conditions that could lead to falls (several times per day, every day, several times per week or several times per month).

The St. Louis Audit of Fall Risks (SAFR) (Kaskutas, et al., 2008) measured *observable worksite behaviors*; it was modified to reflect changes in the federal fall prevention standards that were enacted early in this project. The SAFR consists of 52-items (modified version had 62-items) within nine domains: general safety, walking surfaces, ladders, scaffolds, floor joist and sheathing installation, wall and window installation, roof truss layout/ erection, roof sheathing, and use of conventional fall protection (personal fall arrest, guardrails and safety nets). Each audit item is scored as safe or unsafe based on specified criteria. The SAFR has been shown to be reliable and valid when administered by a trained evaluator (Kaskutas, et al., 2009), including the research assistant in this project (Kaskutas, et al., 2008). Each audit was discussed with the research coordinator after administration to assign safe/un-safe ratings to each audit domain.

Intervention

The 8-hour fall prevention and safety communication foremen intervention has been previously described (Kaskutas, et al., 2013), including needs assessment, curriculum development, training details, and results from pilot testing with ten foremen participants. The intervention occurred at a carpenters' apprenticeship training center affiliated with the CDC-StL; however pilot testing occurred in a classroom setting. This training center has a large shop area with a portion of a full-size home to demonstrate fall protection methods during most stages of home construction. Two carpenter apprentice trainers with fall prevention expertise and an occupational health researcher (VK) led the training. The lead trainer had prior work experience as a residential foreman and superintendent. We used adult learning methods, participatory exercises, and small group activities to actively engage the learners. Training modules included fall protection methods, fall prevention plans, auditing the worksite to identify hazards, abatement of fall hazards, effective tool box talks, safety communication and feedback, juggling safety with productivity, and empowering journeymen to mentor inexperienced workers. While much of the training was applicable to general safety, three high-risk stages of the residential construction process received specific emphasis; including erecting floor joists and roof trusses; installing floor, wall, and roof sheathing; and working at edges and floor openings.

At the beginning of the training, results from the two pre-training visits were shared with the participants to discuss baseline performance and identify areas needing improvement. The carpenter trainer presented methods to reach compliance with federal safety standards and demonstrated many of these methods on the building prop. Use of fall prevention plans, when conventional fall protection methods were infeasible or posed a greater hazard was also covered in the training. Foremen were instructed how to administer the modified SAFR to identify worksite hazards. Small group problem solving activities were performed for stages of home construction emphasized in the training, which facilitated open dialogue among participants. After the fall prevention portion, the training shifted to safety communication; including identifying your crewmembers' knowledge and skill set, how to train crewmembers, designing daily tool-box talks to address safety concerns and delivering these talks, mentoring workers, and providing regular feedback. Videos filmed on the construction prop demonstrated examples of effective and ineffective safety feedback to crewmembers.

Analysis

The mean self-reported frequency for 6 fall prevention behaviors, mean agreement score on the 10 safety climate items (8 on crewmember survey) , and the mean Zohar score (10 items on crewmember survey and 5 items on foremen survey) were computed. Scores were converted to a 100-point scale with higher scores indicating better performance. At least 80% of the items within a scale needed to be answered to compute scale scores. Internal consistency of the scales was assessed using Cronbach's alpha.

We collapsed survey items with ordinal responses at a cut-point that corresponded to levels recommended during the intervention; this included delivering toolbox talk at least once per week, addressing the best way to perform risky work tasks during the toolbox talks, providing daily crewmember instruction, and critically observing the worksite for fall risks several times per day. Regarding the effects of toolbox talks, we analyzed whether or not foremen indicated that, "Most carpenters learn from these safety talks and become more safety focused." For day-to-day instructions, we analyzed whether or not these interactions were reported to help crewmembers work safely. The percent of the foremen participants and crewmembers who answered the one knowledge question correctly was computed.

In order to corroborate the foremen's reports, we compared the crewmembers' and foremen's reports for all scales and items that were similar. Worksite audit ratings were compared to survey results to corroborate self-reported ratings. To assess the specificity of the intervention, we identified items on the survey and audits that were emphasized in the training and compared scores between emphasized and non-emphasized items. We also compared pre and post-training lumped scores between the 7 participating contractors and two levels of management (foremen group versus superintendent, safety director and owner group) that participated in the training to explore the effects of the training on different participant sub-groups.

To assess the effectiveness of the intervention, we used mixed regression models to test for immediate changes post-training (6 and 12-week surveys) and sustained changes (6-months post-training). Hierarchical linear models were fit to the foremen survey to predict changes in our continuous outcomes (i.e. scales and percent of time follow fall prevention methods) and dichotomous and ordinal outcomes; similar hierarchical models were fit for the crewmember survey. Crewmember surveys represented multiple observations for their respective foremen (individual crewmembers were not followed longitudinally), with foremen nested within their respective companies. We produced logit mixed models for the two-level outcomes and cumulative logit mixed models for the three-level outcomes. The five time points, represented dichotomously as pre-intervention (time points 1 and 2) versus post-intervention (time points 3, 4 and 5), served as the primary fixed effect predictor. The models included random intercepts for company. We considered the possibility of effect modification from foremen work experience, however we found that this effect did not exist in any models.

In order to estimate the effect of the intervention on worker falls, we used information gathered from surveys that we had recently administered to apprentice carpenters (n=1,220). Apprentices self-reported work-related falls from heights that they had experienced in the past year and rated the frequency of fall prevention behaviors practiced by their crews using the same behavior scale used in the current research. We estimated the change in fall risk that could result from behavior changes seen in the current study using the associations observed between this behavior scale and reported falls in our prior study (Kaskutas, et al., 2010). All analyses were completed using SAS version 9.4 (SAS Institute, 2013).

RESULTS

We held 6 training waves with 84 residential construction professionals, including 71 foremen, 5 superintendents, 4 owners, 3 safety directors, and 1 project manager. Table 1 includes demographics for each of the 5 measurement points. Participating foremen were not always able to be surveyed due to work schedule, availability, and because some occasionally worked as crewmembers rather than foremen due to the drop in new home construction that occurred during our study. We were able to survey crewmembers working for at least 60% of the participating foremen at each time-point; including 235 crewmembers pre-intervention, 250 post-intervention, and 93 at extended follow-up. The foremen participants had a high level of experience in the carpentry trade and a mean of over 10 years of tenure with their current employer. The crewmembers had significantly fewer years of work experience and tenure with their employer. The results of the pre-training surveys were similar between the two pre-training visits, suggesting that conditions were stable prior to the intervention, so we combined the two pre-training visits into one pre-intervention category. Six and 12-week post-training results were also very similar, so they were combined into a post-intervention group. Internal consistency of the scales measured with Cronbach's alpha was moderate to high (Safety climate =.866 foremen and.843 crewmembers, Zohar =.762 foremen and .890 crewmembers, Behavior scale =.686 foremen and .807 crewmembers).

Table 2 demonstrates results from the hierarchical linear models with foremen nested within contractors. Pre-intervention ratings were similar between foremen and crewmembers for all areas surveyed, suggesting that the foremen's ratings accurately reflected the crewmembers' perceptions. Increased frequency of fall prevention behaviors was a primary goal of the intervention. The hierarchical models showed large, sustained, and statistically significant improvements in fall safety behaviors, suggesting a large effect of training on both foremen and their crewmembers. These models also demonstrated large statistically significant increases in the number of foremen delivering weekly toolbox talks and in the focus of these talks on methods to perform risky work tasks. Both foremen and crewmember knowledge about fall prevention improved, suggesting that participating foremen diffused the information learned during the training session to their crewmembers through toolbox talks and mentoring interactions. Larger improvements were noted for areas that were emphasized during the foremen's training (fall prevention behaviors and knowledge and toolbox talk frequency and active delivery methods) and the magnitude of improvements noted were similar between foremen and crewmembers. Model estimates for the safety climate scale demonstrated improved foremen's perception post-training and at follow-up; crewmembers' perceptions of safety climate also improved but did not reach significance ($p = 0.068$). A second measure of safety climate, the Zohar scale, did not show significant changes in the composite score, though one of the items, "foreman approaches workers to discuss safety issues," showed statistically significant improvement post-intervention by the crew members ($p = 0.02$), suggesting that crew members recognized a change in their foreman's focus and communication on safety issues. The reported frequency of daily worker instruction, and beliefs that daily instruction increases safety behaviors did not change among foremen or crewmembers. (Table 2) Changes in observed behaviors were mostly in the direction of being safer; however we did not have enough observations to detect statistically significant changes.

When we examined specific behavior items independent of the hierarchical model, large improvements were noted post-intervention for areas that were emphasized in the training when compare to those that were not emphasized; many of these improvements persisted at follow-up. For example, foremen's post-training reports of the frequency of working from the top plate of framed walls, a very unsafe behavior, decreased (odds ratio (OR) =6.0 post-training and at extended follow-up), as did the crewmember reports (OR=3.27 post-training and 2.82 extended follow-up). These self-reports were corroborated during worksite visits performed by our trained auditor, with fully safe methods observed 58% of the time prior to the intervention and 79% post-training. The OR for working while standing on a floor joist, another common unsafe behavior, demonstrated statistically significant decreases post-intervention (foremen' OR=3.22 and crewmembers' OR=1.65) and at extended follow-up (foremen' OR=4.30 and crewmembers' OR=1.55). Another method used commonly to install floor sheathing is to stand on ladders, which may seem to be an innocuous activity, however ladders account for the majority of construction worker fatalities (CPWR - The Center for Construction Research and Training, 2013). When we examined self-reported ladder behaviors, large, statistically significant increases in safe step and extension ladder set up and use were reported post-training and at extended follow-up by foremen and their crewmembers. Regarding use of personal fall arrest systems, statistically significant increases in equipment use were reported by foremen (OR=2.31 post-intervention and 2.01 extended follow-up) and crewmembers (OR=2.66 and 3.67 respectively). Worksite audits corroborate that personal fall arrest systems were being used more often, but they were often set-up incorrectly, suggesting that further training is needed. Lastly, a greater proportion of crewmembers reported that they were familiar with their company's fall prevention plan after participant training and at extended follow-up, which also suggests that crewmember training improved.

When examining differences between levels of management and contractors participating in the intervention, we found that the foremen and upper management groups reported similar safety behaviors before and after the intervention. The safety climate was perceived to be 12-points better by upper managers when compared to foremen, and foremen perceived a better safety climate than their crewmembers, demonstrating the importance of measuring safety climate at different levels within an organization. The contractor that demonstrated the largest improvements in safety behaviors, safety climate, and toolbox talks sent all levels of management to the training and participated in the intervention just prior to the date that more stringent federal safety standards were taking effect (Kaskutas, et al., 2014).

Although we were unable to directly measure the impact of the intervention on falls from height among participating foremen and their crewmembers, our previous study among apprentice carpenters showed that a 1-point increase in the fall safety behavior scale score was associated with a 1.4% decrease in the incidence of self-reported falls in the past year (Kaskutas, et al., 2010). Extrapolating to the current project, we would expect that the observed post-intervention increase of 11.9 points on the fall safety behavior scale would be associated with a 16.6% decrease in the one year cumulative incidence of self-reported falls among apprentice carpenters following the intervention.

DISCUSSION

The intervention described in this research resulted in sustained improvements in fall prevention behaviors and safety communication in residential construction, a hard-to-reach sector of workers with excessively high morbidity and mortality due to falls. Combining fall prevention and safety communication training equipped the foremen participants with the requisite knowledge, tools, and skills needed to lead their work crews toward safer methods of performing work on elevated surfaces. Importantly, both the foremen *and* the workers on their crews reported improvements in fall prevention behaviors and safety communication after the intervention. These improvements seen in crewmembers' behaviors suggest that the foremen who received training assimilated and disseminated portions of the training to their crewmembers. This view is supported by the reported increases in the frequency of toolbox talks, and their increased focus on relevant safety issues.

This research suggests that providing foremen with communication training at the time of safety-specific training will improve their abilities to influence the safety behaviors of their employees. Most construction foremen possess an excellent skill set in their building trade; however many are being placed in safety leadership roles that they may not prepared to assume. As the economy rebounds, 1.3 million workers are projected to join the construction workforce by 2020 (CPWR - The Center for Construction Research and Training, 2013). Residential contractors and foremen will need to train these new workers to safely perform the wide array of work tasks that are regularly performed at the worksite. Training foremen to juggle their production, safety, and mentorship roles can improve worker safety and ultimately prevent falls from heights at residential worksites.

Although this intervention did not target safety climate or safety culture, post-intervention ratings suggest that safety climate was improved, with greater changes observed among the foremen. Our intervention was in part aimed at improving safety communication between foremen and their crews, which likely affected perceptions of safety climate at all levels. Hahn and Murphy (2008) found that safety climate correlated strongest with effective communication and more frequent qualitative feedback between managers and employees. Differing perceptions of safety climate between front-line workers, their supervisors, and management were evident in this research, suggesting that future studies addressing safety climate should measure at multiple levels of the organization. Safety climate and culture are emerging priorities for construction safety and health (National Occupational Research Agenda,

2008) that encompasses “deeply held but often unspoken safety-related beliefs, attitudes and values that interact with an organization’s systems, practices, people, and leadership to establish norms about how things are done in the organization” (CPWR - The Center for Construction Research and Training, 2014). Our intervention was not intended to be delivered to an entire organization, but several levels of management from a few contracting companies did participate in the training.

We made multiple cross-sectional measures of each participating foreman’s crew rather than following individual crewmembers longitudinally as workers naturally flow on and off of residential work crews. Although this is a potential limitation of this research, it provided an accurate reflection of the transient nature of residential construction crews. Multiple cross-sectional measures instead of longitudinal follow-up of individual crew members is most likely to have resulted in an underestimation of the effects of the training on the crewmembers, as they would have had less exposure to the trained foreman and fewer opportunities for transfer of safety practices. The pre-post design was also a limitation of this study, as we lacked a concurrent control group. We did observe larger improvements in areas that were emphasized in the training, suggesting specificity of effect and supporting the conclusion that the observed effects are not due at least in part to the intervention. Due to the economic downturn, there were fewer active worksites than anticipated, which left us inadequately powered to detect changes in observed worksite behaviors, as the high risk behaviors that were the emphasis of this intervention occur only intermittently. Changes in the federal fall prevention safety standards for residential construction may also have affected our results; however we saw similar improvements in all six training waves over the four-year intervention period, including companies that participated prior to the changed federal standards, during the changes, and afterward.

Our sample was representative of the predominantly unionized residential construction workforce in the St. Louis metropolitan area, but not of the residential workforce across the country, which is mostly non-union and may utilize temporary day workers. Because the intervention was delivered to contractor-based groups of foremen, we believe that this intervention could readily be delivered to groups of foremen within non-union contractors, provided the contractor was willing to support the program. It is plausible that a foreman safety and communication intervention would show even larger improvements in safety behaviors if delivered to non-union foremen and crews, who typically receive much less safety training than our apprenticeship trained St. Louis workforce. Detailed intervention objectives and learning activities outlined in a training manual ensured that the intervention was consistently delivered, and increase portability of this intervention to other settings. Future research to test this intervention with non-union residential workers in other parts of the country is suggested, as well as conversion to a web-based format available in other languages to enhance wider dissemination than could be achieved with the classroom format used in our intervention.

This research adds to the growing literature demonstrating that needs-driven training can improve construction worker safety and worksite safety communication. Providing participants with baseline performance metrics and actively engaging learners in small group problem-solving are proven educational methods that are applicable to the construction sector. Most residential construction companies are small and their workforce is often transient and widely dispersed, limiting access to effective training and safety supervision. By using innovative delivery methods, we can extend the reach of safety and health training to this sector of the construction workforce with the greatest exposure to unprotected work on elevated surfaces.

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Ethics Review and Approval: The Washington University School of Medicine's Institutional Review Board approved this study. All participants provided informed written consent and were compensated for their participation.

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Table I. Demographics

	Pre-Intervention		Post-Intervention		
Time point	**1**	**2**	**6-weeks**	**12-weeks**	**24-weeks**
Foremen surveys (n)	83	65	77	68	49
Crewmember surveys (n)	137	98	134	116	93
Number of trained foremen with crewmember surveys (n)	52 (63%)	40 (62%)	54 (70%)	42(62%)	34 (69%)
Worksite audits (n)	55	41	56	44	36
Number of participating companies (n)	7	5	7	7	5
Years of work experience among foremen (mean)	18.32	17.79	19.03	18.74	18.47
Years of work experience among crewmembers (mean)	7.62	7.93	9.35	8.85	8.15
Crewmembers that are apprentices (n)	83 (60%)	59 (60%)	66 (49%)	67 (58%)	59 (63%)
Years crewmembers have worked with current foremen (mean)	1.46	1.55	2.21	1.83	1.51
Years foremen have worked with current contractors (mean)	11.61	10.80	13.35	12.72	11.57

Table II. Survey Results

	FOREMEN					CREWMEMBERS				
	Descriptive Statistics			Mixed Model Estimates		Descriptive Statistics			Mixed Model Estimates	
	Pre	*Post*	*Follow-up*	*Post*	*Follow-up*	*Pre*	*Post*	*Follow-up*	*Post*	*Follow-up*
Scales	**Mean**			**Coefficient* (p-value)**		**Mean**			**Coefficient* (p-value)**	
Behavior Scale	64.3	76.2	78.0	13.02 (<.0001)	15.92 (<.0001)	61.3	69.7	66.9	10.99 (.0000)	10.50 (.0000)
Safety Climate Scale	76.8	79.3	78.8	2.60 (0.008)	3.68 (0.009)	72.2	73.2	72.8	2.54 (0.072)	3.38 (0.068)
Zohar Scale	80.0	80.9	80.5	1.25 (0.215)	1.73 (0.222)	71.2	69.4	70.2	0.19 (0.901)	1.84 (0.351)
Self-reported % of time worker uses fall protection	88.4	91.9	92.2	3.60 (.0002)	4.83 (.0005)	81.8	84.4	81.6	3.51 (0.069)	4.62 (0.068)
Self-reported % of time coworkers use fall protection	87.3	91.4	91.9	4.15 (<.0001)	5.51 (<.0001)	83.4	85.5	83.5	3.39 (0.083)	5.33 (0.038)
Items	**Percent**			**OR (95% CI)****		**Percent**			**OR (95% CI)****	
Knows top plate work not	56.2	77.3	87.2	6.08	9.31	46.5	63.9	63.9	2.65	1.58

allowed without fall arrest				(3.07, 12.03)	(3.17, 27.32)				(1.68, 4.18)	(0.9, 2.77)
Toolbox talks occur at least weekly	58.1	80.7	85.7	4.22 (2.21, 8.05)	6.34 (2.38, 16.91)	64.6	79.4	75.2	1.96 (1.21, 3.18)	2.22 (1.16, 4.25)
Toolbox talks focus on best way to perform daily tasks	40.5	60.7	53.1	2.37 (1.39, 4.03)	1.99 (0.95, 4.18)	36.5	51.4	47.8	1.89 (1.26, 2.84)	1.87 (1.1, 3.19)
Foreman provides daily worker instruction	69.0	77.6	75.0	1.65 (0.91, 2.99)	1.38 (0.60, 3.21)	70.8	69.7	71.8	1.31 (0.87, 2.66)	1.52 (0.87, 2.66)
Believes daily instructions help crew work safely	64.2	58.6	59.2	0.79 (0.48, 1.30)	0.83 (0.41, 1.67)	48.5	43.1	37.7	0.93 (0.63, 1.36)	0.79 (0.47, 1.32)

*From Hierarchical linear models with foremen nested within contractors. Estimates refer to a three level time point indicator: pre intervention (reference), post intervention, and extended follow-up

**From Hierarchical logit models with foremen nested within contractors. Estimates refer to a three level time point indicator: pre intervention (reference), post intervention, and extended follow-up