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A training intervention to improve frontline construction leaders' safety leadership practices and overall jobsite safety climate

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ABSTRACT

Introduction: The 2.5 h *Foundations for Safety Leadership* (FSL) training program teaches construction supervisors the leadership skills they need to strengthen jobsite safety climate and reduce adverse safety-related outcomes. *Methods*: Using a quasi-experimental prospective switching replications study design, we examined (1) if FSL-trained jobsite safety leaders would report improved understanding and practice of the FSL leadership skills, safety practices and crew reporting of safety related conditions, and (2) if their crew perceived a change in (a) their supervisors' practices, (b) their own safety practices and reporting of safety-related conditions, and (c) overall jobsite safety climate. Twenty construction sub-contracting companies were recruited and randomly assigned to either an early or lagged-control training group. Participating supervisors and workers completed surveys at multiple time points before and after the FSL training. We used linear mixed modeling to test changes over time. *Results*: Only supervisors in the early group reported a statistically significant improvement in their understanding and practice of the leadership skills as well as safety practices from before to 2- and 4-weeks post-training. Overall, no significant change was detected in crew-reported outcomes from before to after their supervisors' participated in the FSL training. *Conclusions:* These results provide evidence that the FSL training can, at least in the short-term, improve construction frontline leaders' jobsite leadership skills. Future research could include an evaluation of FSL refresher activities and a longer-term follow-up. *Practical applications:* The Foundations for Safety Leadership (FSL) program fills an identified need for construction frontline supervisors to learn and practice critical safety leadership skills on the jobsite. It has already reached over 60,000 leaders and has the potential to reach over 100,000 each year during either an OSHA 30-h or a stand-alone course.

1. Introduction

Safety leadership, conceptualized as a multidimensional construct reflecting a value for safety, is demonstrated through actions and practices that can directly influence worksite safety (Barling, Loughlin, & Kelloway, 2002). Recent research across multiple industry sectors, including construction, has shown that there is a relationship between safety leadership, safety climate (i.e., employee perceptions of company commitment to jobsite safety), and other safety outcomes (Clarke, 2013; Hoffmeister et al., 2014). Despite the evidence, few training interventions have been created and implemented to improve frontline supervisors' leadership skills and evaluate the effectiveness of such training to improve safety leadership practices and jobsite safety climate in the construction industry (Lee, Huang, Cheung, Chen, & Shaw, 2018).

Seventeen years ago, Zohar (2002) developed a feedback-based training program to increase the frequency of safety communication (one dimension of safety leadership) between supervisors and workers employed in a heavy duty equipment maintenance setting. After

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implementation, they observed an increase in supervisor-worker safety communication as well as improved worker safety climate perceptions, ear plug use, and lower injury rates. Since then, three other studies testing similar interventions found comparable results (Kines et al., 2010; Zohar, 2002; Zohar & Luria, 2003). Mullen and Kelloway (2009) evaluated the impact of a 1-day training program provided to Canadian healthcare industry leaders that covered general and safety-specific transformational leadership theory and goal setting. Compared to a control group, those receiving the training showed a positive change in safety attitudes, self-efficacy, and intentions to promote safety and employee reports of improved safety leadership practices and safety climate.

More recently, von Thiele Schwarz, Hasson, and Tafvelin (2016) evaluated the effectiveness of a 20-day leadership training program with Swedish forestry leaders and their workers that included 360° feedback, didactics, goal setting, and on-the-job practice. Their findings showed a positive change in leader safety leadership practices and worker reported safety climate. In a recent process evaluation article (i.e., no outcome data were collected), Jeschke et al. (2017) described the successful implementation of a 22-h training program for construction site supervisors in Denmark that included topics such as communication, conflict management, and safety. Finally, Bronkhorst, Tummers, and Steijn (2018) evaluated a six-month, multi-faceted intervention in which senior management in five healthcare companies conducted safety walk-arounds, supervisors completed safety leadership training, and all team members participated in an online platform where they could discuss safety issues. Findings showed evidence of a positive change in safety climate and safety participation in the intervention group only.

Beyond this empirical evidence, construction industry stakeholders attending a 2013 CPWR/NIOSH sponsored safety climate/culture workshop identified “Improving Supervisory Leadership” as a key leading indicator of a strong jobsite safety climate (CPWR: The Center for Construction Research and Training, 2013). The stakeholders remarked that to improve safety climate, companies need to distribute safety responsibilities to frontline leaders who have the skills to: (a) communicate their own values and the company's values and expectations for safety; (b) coach and teach crew members about safety; (c) motivate all employees to participate in the safety program; and, most importantly (d) lead by example. This feedback, along with the empirical evidence reported above, led our research team to develop the Foundations for Safety Leadership (henceforth referred to as FSL) training program (see Goldenhar, Schwatka, and Johnson, 2019, in this issue for more detail on the FSL).

The two overarching goals of this study were to assess if after FSL training: (1) frontline construction company supervisors (henceforth called safety leaders) would report a greater understanding and increased practice of the learned safety leadership skills, improve their own safety practices, and report improved crew reporting of safety related conditions and, (2) their crew members (henceforth referred to as workers) would perceive an improvement in their leaders' use of safety leadership skills, improvement in their own safety practices and reporting of safety related conditions, as well as a stronger jobsite safety climate.

2. Methods

2.1. FSL training intervention

The FSL is a 2.5-h training program designed to address the construction industry's stated need to improve foremen and frontline leaders' safety leadership practices, strengthen overall jobsite safety climate, and ultimately reduce the incidence of adverse health and safety outcomes. Creating the program was a collaborative effort carried out by a 17-member curriculum development team that included Occupational Safety and Health Administration (OSHA) 30-h trainers, safety and health professionals from small and large construction companies (both union and non-union), as well as researchers from CPWR and four universities. The training materials cover the direct and indirect costs of ineffective safety leadership, the benefits of effective safety leadership, and how to practice five critical safety leadership skills on the jobsite. The five safety leadership skills emphasized in the training include: Leading by example; Engaging and empowering team members; Actively listening and Practicing 3-way communication; Developing team members through teaching, coaching, and feedback; and Recognizing team members for a job well done. These skills closely align with the four core factors of safety-specific transformational leadership (Barling et al., 2002; Mullen & Kelloway, 2009). After learning the didactic material presented in section 1 of the module, students have the opportunity to apply the concepts by working through a number of real-world construction scenarios. A full description of how the FSL module and evaluation instruments were developed and pilot-tested can be found in this issue (Goldenhar et al., 2019).

On January 1, 2017, the Occupational Safety and Health Administration (OSHA) approved the FSL as an official 2.5-h elective in their 30-h course and all FSL training materials and other related resources were uploaded to CPWR's website allowing trainers to download and use the materials in stand-alone company or union training and educational activities https://www.cpwr.com/foundations-safety-leadership-fsl (CPWR: The Center for Construction Research and Training, 2018). Over 60,000 leaders have received the FSL training since the official roll-out January 1, 2017.

2.2. Study participants

2.2.1. Companies

A power analysis estimating a moderate effect size for leaders, a small effect size for workers, and a goal to achieve a power of 0.90 indicated that at least 200 leaders and 1000 workers were needed to participate in the study to detect any change in measured constructs from before to after the FSL training. To meet this goal, we used a purposeful sampling strategy (Patton, 2015) to identify sub-contracting companies that employed at least 10 foremen who supervised at least 5 workers and would participate in the training. To maximize the generalizability of the study's results, we recruited companies that were diverse in union status, geographic location, and trade risk based on Bureau of Labor of Statistics injury and fatality data (Bureau of Labor Statistics, 2018). We also recruited small, medium, and large companies as defined by the number of full-time equivalents.

The company contact, typically the owner or safety director, identified and provided names and jobsite location of foremen or other frontline lead workers (i.e., leaders) and their crew members who could potentially participate in the study. The research team obtained permission from the contact to visit jobsites during morning/afternoon huddles or schedule meetings to explain the study objectives to the work crews, describe the logistics of participation, and obtain their consent. The majority of leaders and workers we met with chose to participate. Each was given a unique identifier that was used to track survey responses over time.

2.2.2. Leaders and workers

At the initial jobsite visit, leaders who consented to participate completed a baseline survey, were reminded that there would be follow-up surveys, and were asked to attend an FSL training which would be scheduled to take place at a convenient time identified by the company contact. There was no cost to attend the training and a meal was always provided. Workers who consented also completed a baseline survey, were informed of follow-up surveys, and received a $5 gift card for each survey completed.

2.2.3. Trainers

In each geographic location (details below), we identified and recruited instructors to conduct the FSL sessions who did not work for the participating company and had previously conducted occupational health and safety training programs with construction workers. All trainers attended a train-the-trainer session during which they participated in the full FSL training and were instructed not to deviate from the procedures outlined in the instructor guide when conducting the training themselves. Trainers were compensated for the time spent preparing for and delivering the training. At least one member of the research team was present at each FSL training session and was responsible for collecting immediate pre and post-training surveys.

2.3. Study design & data collection

2.3.1. Design

Our industry partners informed us that companies would be less inclined to participate in the study if there was a chance they would be assigned to a control group in which their employees would be asked to complete surveys but their frontline leaders would not receive the training. Therefore, rather than using a randomized controlled trial to evaluate the FSL training, we used a quasi-experimental prospective switching replications study design (Sadish, Cook, & Campbell, 2002).

The switching replications design with multiple waves of data collection is strong in terms of internal and external validity and is superior to the simple pre-post nonequivalent groups design because it assures that all participants eventually get the training; making it also more ethical. First, both groups complete pretests, then only one is given the training and both complete post-tests. Then, the comparison group is given the training while the original group serves as the "control" (Web Center for Social Research Methods, 2006).

The initial plan was to collect follow-up data at 1- and 3-months post-training to allow time for the trained leaders to incorporate the five FSL skills into their daily routines. However, our curriculum development team and other construction subject matter experts said that the realities of working in the construction industry would make a 3 month follow-up extremely difficult. That is, because work on a construction site is constantly in flux with old tasks being finished and new ones needing to be completed, different skilled trade workers come and go on a regular basis and at 3-months post-training most of the crews would likely be disbanded and working on a new job site with a different foreman or lead worker (Sparer et al., 2015). For the study, this meant that it would be almost impossible to find and survey crew members who had consistently worked with the same leader over that longer time period. Therefore, we followed our construction experts' advice and planned to collect post-training data from participants at 2 weeks and again at for 4 weeks from the early group only. All study procedures and materials were approved by the University of Colorado Boulder Institutional Review Board.

2.3.2. Surveys

To assess the impact of the FSL, we developed pre- and post-training surveys designed to collect data from the trained leaders and the workers they oversee. In addition to demographics, the surveys included items to measure the outcome variables presented in Table 1. A full description of survey development, including items, scales, and reliability testing can be found in Goldenhar et al. (2019) in this issue of JSR.

Table 1
Outcome variables (All use a 1–5 Likert response scale).

Leaders	Workers
• Understand leadership skills	• Leaders' use leadership skills
• Use leadership skills	• Safety climate
• Use safety practices	• Use safety practices
• Crew reporting safety-related conditions	• Self-reporting of safety-related conditions

2.4. Training and data collection

In Table 2, we illustrate training and data collection activities for both the early intervention and lagged control group. Specifically, leaders in the early group completed surveys immediately before and after the training as well as approximately 2- and 4-weeks after the training. Their workers were asked to complete a survey 1-week before as well as 2- and 4-weeks after the training. The 4-week post-training data gathered from the early group was used to assess sustained training impact. Leaders in the lagged-control group completed surveys 4-weeks prior to and immediately before the training, as well as immediately after and 2-weeks post training. Since the lagged-control group participants completed a survey 4-weeks prior to the training, we limited their survey burden by not asking them to complete another one 4 weeks post-training.

2.5. Data analysis

To assess the effectiveness of the FSL, we conducted linear mixed modeling analyses with Stata version 14.2 (StataCorp, 2015) to test the following hypotheses:

H1. Compared to the leaders in the lagged-control group (Pre_T0, ref = T-2), the leaders in the early group will show an increase in their:

a) Understand leadership skills (Post_T0, ref. = Pre_T0)
b) Use of leadership skills (T + 1, ref. = Pre_T0)
c) Use of safety practices (T + 1, ref. = Pre_T0)
d) Crew reporting of safety-related conditions (T + 1, ref. = Pre_T0)

H2. Compared to workers of leaders in the lagged-control group (T-1, ref = T-2), workers in the early group will report:

a) An increase in their leader's use of the leadership skills (T + 1, ref. = T-1)
b) An enhanced safety climate (T + 1, ref. = T-1)
c) An increase in their use of safety practices (T + 1, ref. = T-1)
d) An increase in their reporting of safety-related conditions (T + 1, ref. = T-1)

We used a two-stage model building strategy to test the first two hypotheses. In model 1, we included a binary variable representing time of survey (see listed hypotheses above for detail on which time points were compared). In model 2, we added a binary variable representing intervention group (0 = Lagged-control group, 1 = Early group) and an interaction term between the time and group variables to test if the responses over time were different in the two groups. We compared the goodness of fit of the simpler model with just time (model 1) to the more complex model with time and group variables (model 2) using the likelihood ratio test. In both models, we accounted for the fact that we repeatedly measured the outcome variable by nesting the scores within participant at each data collection time point. We also included a random intercept to allow scores to vary across participants prior to the training. Finally, we controlled for ethnicity (Hispanic vs. Non-Hispanic), survey language (Spanish vs. English), and leaders' self-report learning goal orientation, which has been linked to learning during training (Johnson et al., 2018).

Because the unit of analysis for Hypotheses H2a-d is the leader, we combined and averaged their workers' survey responses for each outcome variable at each data collection point. The within-group homogeneity as measured by the intraclass correlation coefficient (ICC,1) was acceptable for workers' perceptions of leader's use of leadership skills

Table 2
Data collection time points by intervention group.

		Intervention group	
		Early	Lagged-Control
Survey data collection before and after FSL training	Leaders	Immediately before (Pre_T0)	4-weeks before (T-2)
		FSL TRAINING	Immediately before (Pre_T0)
		Immediately after (Post_T0)	FSL TRAINING
		2-weeks after (T + 1)	Immediately after (Post_T0)
		4-weeks after (T + 2)	2-weeks after (T + 1)
	Workers	1-week before (T-1)	4-weeks before (T-2)
		LEADERS' FSL TRAINING	1-week before (T-1)
		2-weeks after (T + 1)	LEADERS' FSL TRAINING
		4-weeks after (T + 2)	2-weeks after (T + 1)

(0.28 [95% CI = 0.21–0.37]), safety climate (0.11 [95% CI = 0.06–0.19]), safety practices (0.11 [95% CI = 0.06–0.18]), and self-reporting of safety-related conditions (0.16 [95% CI = 0.10–0.24]). Other safety climate and safety leadership researchers have observed similar ICC(1)s (Zohar & Polachek, 2014).

To test the hypotheses 3 and 4 we analyzed the post-training data gathered from the early intervention group only to assess the degree to which leader and worker outcome variables changed from 2- to 4-weeks after the FSL training (T + 2, ref. = T + 1).

H3. Compared to 2-weeks, at 4–weeks post training, leaders will report maintained or improved:

a) Use of leadership skills
b) Use safety practices
c) Crew-reporting of safety-related conditions

H4. Compared to 2-weeks, at 4–weeks post training, workers will report maintained or improved:

a) Leader's use of leadership skills
b) Safety climate
c) Use of safety practices
d) Self-reporting of safety-related conditions

Specifically, we included a binary variable representing time of survey in the model, accounted for repeated measures, included a random intercept, and controlled for ethnicity, survey language, and leaders' self-report learning goal orientation.

3. Results

3.1. Study sample

We successfully recruited a diverse sample of 20 construction subcontracting companies in 3 geographic U.S. locations: 14 in the West, 3 in the Midwest, and 3 in the East. The companies in each location were randomly assigned to either the early or lagged-control group (as described earlier). Ten were self-described as medium-sized (50%). Eleven (55%) identified as union contractors and 11 (55%) specialized in high-risk trades as defined by Bureau of Labor of Statistics injury and fatality data (Bureau of Labor Statistics, 2018). The most common trades represented were heavy civil (n = 5), drywall (n = 5), electrical (n = 4), labor (n = 4), and mechanical (n = 3) (see Table 3).

Study participants were primarily white males between 38 and 45 years old. More than 70% of the leaders reported having worked with their current company for more than 4 years and a majority were in a foremen/lead person role. Less than 42% of workers had worked with their current company for more than 4 years and a majority said they were an experienced worker or apprentice/trainee. Twelve percent of leaders and 20% of workers choose to complete the Spanish language survey (see Table 4). Unfortunately, due to a reduction in the workforce at one of the lagged companies we were unable to gather survey data from their workers. We were able to collect data from five of their leaders and decided to include it in the analyses because a sensitivity test revealed that inclusion of these leaders in the analysis did not significantly change the results.

Of the 286 leaders who received the training (169 early and 117 lagged-control), 77% (n = 130) of leaders in the early group and 84% (n = 98) of leaders in the lagged-control group completed all four surveys. We had survey data from 247 of them (86%) to test Hypotheses 1 a–d. In the early intervention group only, we had survey data from 133 of 169 (80%) trained leaders to test the sustained impact of the training (Hypothesis 3 a–c).

Of the 1173 workers recruited to participate in the study (809 early and 364 lagged-control), 46% (n = 371) of workers in the early group and 55% (n = 202) of workers in the lagged-control group completed all three surveys. To test hypotheses 2a–d we had 706 (60%) completed worker surveys and to test hypotheses 4 a–c we were able to use 458 surveys out of 809 (57%) complete surveys.

3.2. Before and after the FSL training (H1 and H2)

In the following sections, we present the results of the linear mixed modeling analysis for hypotheses 1–2 in which we compared data collected from the early group before to after their FSL training to data collected from the lagged-control group at two time points before they participated in their FSL training. We present the results of model

Table 3
Company characteristics.

	Early (#)	Lagged-control(#)	Total N (%)
Geographic location			
West (Denver area)	7	7	14 (70%)
Midwest (Pittsburgh, PA/ Morgantown WV)	1	2	3 (15%)
Northeast (Boston area)	2	1	3 (15%)
Size (self-reported)			
Small (0–75 FTEs)	2	3	5 (25%)
Medium (76–200 FTEs)	4	6	10 (50%)
Large (201 + FTEs)	4	1	5 (25%)
Union status			
Non-union	6	5	11 (55%)
Union	4	5	9 (45%)
Trade risk level			
Low risk	7	2	9 (45%)
High risk	3	8	11 (55%)

Note. FTEs – Full time equivalents.

Table 4
Participant demographics.

	Leaders (N = 286)		Workers (N = 1173)	
	Early (n = 169) n (%)	Lagged (n = 117) n (%)	Early (n = 809) n (%)	Lagged (n = 364) n (%)
Gender				
Male	163 (99%)	100 (100%)	607 (99%)	300 (100%)
Female	1 (1%)	0 (0%)	9 (1%)	1 (0%)
Age – Mean (SD)	43 (9)	45 (10)	39 (13)	38 (12)
Ethnicity				
White	110 (67%)	79 (79%)	295 (49%)	164 (56%)
African American	3 (2%)	1 (1%)	23 (4%)	12 (4%)
Hispanic	44 (27%)	19 (19%)	270 (44%)	100 (34%)
Asian	0 (0%)	0 (0%)	2 (0%)	0 (0%)
Native American	2 (1%)	0 (0%)	4 (1%)	3 (1%)
Mixed	4 (2%)	1 (1%)	11 (2%)	11 (4%)
Other	1 (1%)	0 (0%)	3 (0%)	3 (1%)
Years in construction – Mean (SD)	21 (9)	23 (9)	13 (11)	15 (11)
Current position				
Supervisor/manager	5 (3%)	4 (4%)	–	–
Superintendent	16 (10%)	20 (20%)	–	–
Foreman/lead person	140 (85%)	73 (72%)	–	–
Experienced worker	–	–	413 (69%)	219 (75%)
Apprentice/trainee	–	–	144 (24%)	50 (17%)
Laborer	–	–	20 (3%)	9 (3%)
Other	3 (2%)	4 (4%)	20 (3%)	13 (4%)
Tenure with company				
<1 year	19 (12%)	6 (6%)	291 (50%)	88 (30%)
1–3 years	29 (18%)	13 (13%)	161 (27%)	84 (29%)
4–6 years	32 (20%)	13 (13%)	80 (14%)	41 (14%)
7–10 years	27 (17%)	14 (14%)	23 (4%)	23 (8%)
10 + years	54 (34%)	54 (54%)	32 (5%)	57 (20%)
Wks w/current supervisor – Mean (SD)	–	–	39 (109)	56 (106)
Location in the US				
West	128 (76%)	82 (70%)	593 (73%)	254 (70%)
Mid-west	15 (9%)	17 (15%)	32 (4%)	38 (10%)
Northeast	26 (15%)	18 (15%)	184 (23%)	72 (20%)
Company size				
Small	26 (15%)	23 (20%)	184 (23%)	58 (16%)
Medium	46 (27%)	70 (60%)	164 (20%)	265 (73%)
Large	97 (57%)	24 (21%)	461 (57%)	41 (11%)
Union status				
Non-Union	110 (65%)	67 (57%)	487 (60%)	185 (51%)
Union	59 (35%)	50 (43%)	322 (40%)	179 (49%)
Trade risk level				
Low risk	114 (67%)	49 (42%)	620 (77%)	181 (52%)
High risk	55 (33%)	68 (58%)	189 (23%)	173 (48%)

2. The results of model 1 along with more detailed statistical results can be found in Supplementary Table S1.

3.2.1. Leaders

The only outcome variable that showed a significant mean group difference *prior to* the training was 'understanding leadership skills;' with the early group having a lower mean score ($\beta = -0.49$ (SE = 0.19), $p < .01$) (see Fig. 1a).

In terms of within group mean scores only, leaders in the early group reported a significant improvement in their "understanding leadership skills" from immediately before to immediately after their training ($\beta = 0.46$ (SE = 0.07), $p < .01$). There was also an increase in their reported use of leadership skills ($\beta = 0.21$ (SE = 0.05), $p < .01$) and safety practices ($\beta = 0.22$ (SE = 0.05), $p < .01$) from immediately before to two-weeks after their training (see Fig. 1a–c).

Leaders in the lagged-control group showed a slight decline in their understanding leadership skills ($\beta = -0.16$ (SE = 0.06), $p < .01$) and showed no significant change in use of leadership skills ($\beta = -0.06$ (SE = 0.04), $p = .14$) or safety practices ($\beta = -0.01$ (SE = 0.04), $p = .71$) from 4-weeks before to immediately before their training (see Fig. 1a–c).

The outcome variable "crew-reporting of safety-related conditions" did not show a significant change for leaders in either group (Early (Pre_T0 to T + 1): $\beta = 0.14$ (SE = 0.09), $p = .14$; Lagged-control (T-2 to Pre_T0): $\beta = 0.02$ (SE = 0.07), $p = .76$) (see Fig. 1d).

The likelihood ratio tests used to examine Hypotheses 1 a–d indicated that when compared to model 1 containing only time effects, for three of the four outcome variables, model 2 with time and group effects fit the data significantly better: H1a – understanding leadership skills (χ^2 (2) = 33.6, $p < .01$), H1b – use of leadership skills (χ^2 (2) = 28.9, $p < .01$), and H1c – safety practices (χ^2 (2) = 22.9, $p < .01$). However, the likelihood ratio test for the outcome variable "crew-reporting of safety-related conditions" (H1d) indicated that model 2 did not fit the data significantly better than model 1 (χ^2 (2) = 0.26, $p > .10$). Together, these findings partially confirm Hypothesis 1.

3.2.2. Workers

Prior to the FSL training, there were no significant group differences in workers' perceptions of their leaders' use of leadership skills ($\beta = 0.13$ (SE = 0.08), $p = .11$), safety climate ($\beta = -0.02$ (SE = 0.06), $p = .72$), safety practices ($\beta = -0.04$ (SE = 0.06), $p = .54$), or self-reporting of safety-related conditions ($\beta = 0.11$ (SE = 0.08), $p = .16$).

We observed slight improvements during the intervention period for the early group and during the control period for the lagged-control group (see Fig. 2a–d). However, the change was not statistically

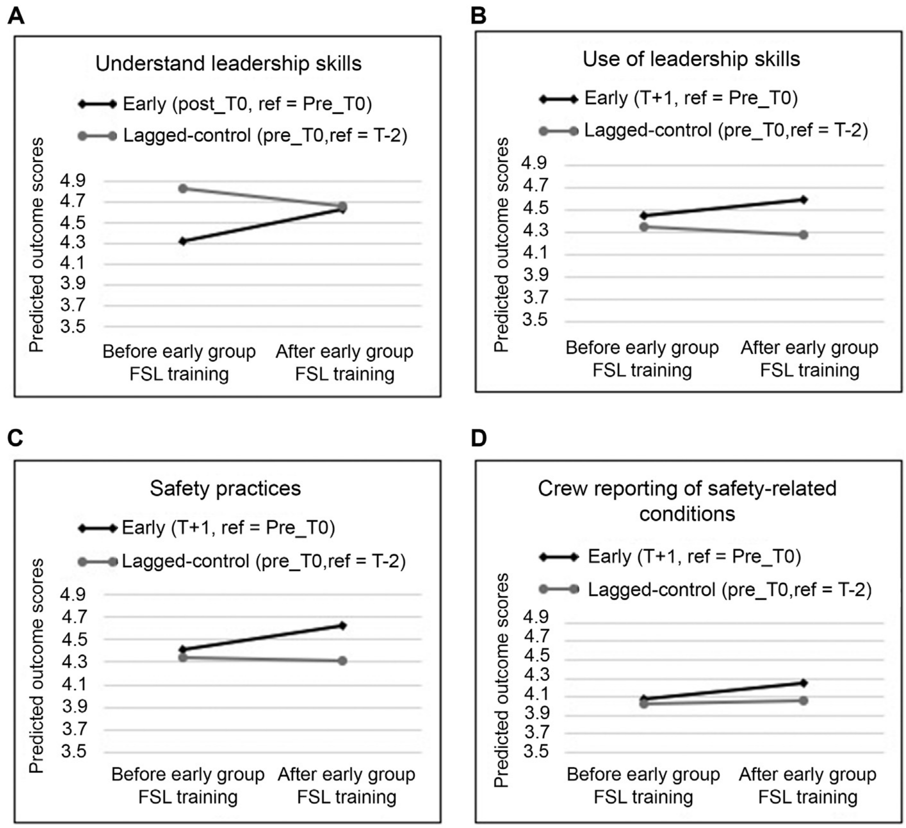

Fig. 1. Results of linear mixed models - predicted average scores for leaders early and lagged control groups (1–5 Likert response scales).

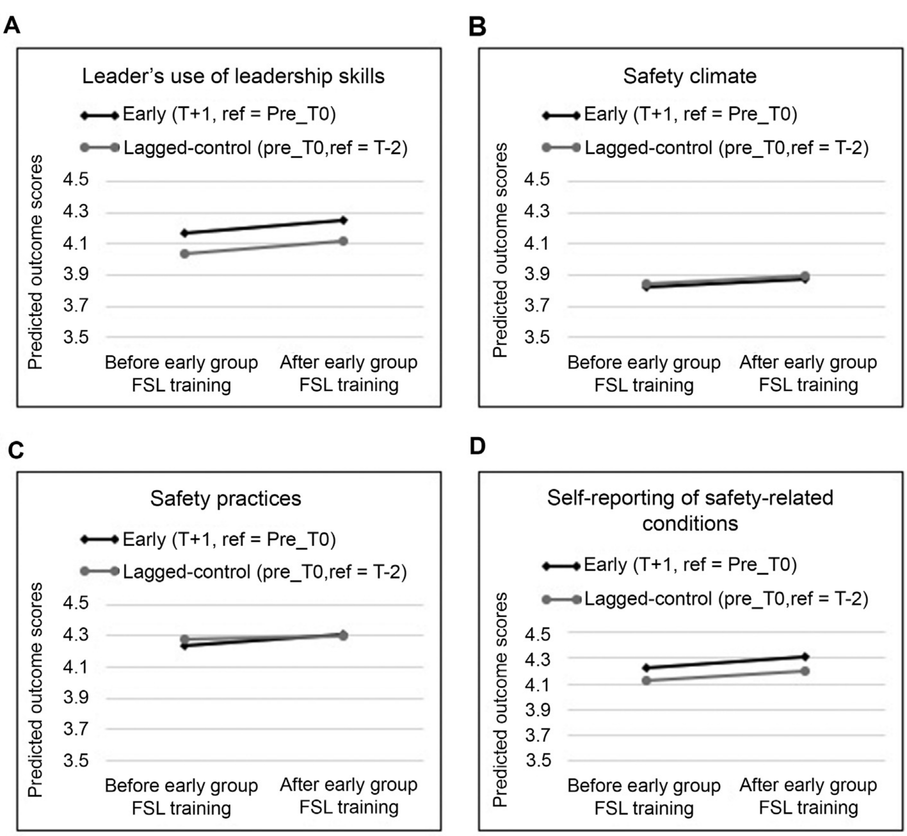

Fig. 2. Results of linear mixed models – predicted average scores for early and lagged-control group worker outcome variables (1–5 Likert response scales).

significant for the early group from 1-week before to 2-weeks after their leaders participated in the FSL training ((leader's use of leadership skills ($\beta = 0.01$ (SE = 0.07), p = .91), safety climate ($\beta = 0.00$ (SE = 0.06), p = .98), safety practices ($\beta = 0.06$ (SE = 0.06), p = .32); self-reporting of safety-related conditions ($\beta = 0.00$ (SE = 0.07), p = .96)), nor for the lagged-control group from 4-weeks before to 1-week before the FSL training ((leader's use of leadership skills ($\beta = 0.08$ (SE = 0.05), p = .16), safety climate ($\beta = 0.05$ (SE = 0.05), p = .30), safety practices ($\beta = 0.01$ (SE = 0.05), p = .76), self-reporting of safety-related conditions ($\beta = 0.08$ (SE = 0.05), p = .15)).

When comparing early group to the lagged control group, the likelihood ratio tests indicated that for all outcome variables, model 2 with time and group effects did not fit the data significantly better than model 1 with the time variable only: H2a – leader's use of leadership skills (χ^2 (2) = −1.5, p > .10), H2b - safety climate (χ^2 (2) = −5.28, p > .10), H2c - safety practices (χ^2 (2) = −4.5, p > .10), and H2d – self-reporting of safety-related conditions (χ^2 (2) = −2.48, p > .10). Thus, we cannot confirm Hypothesis 2 a–d.

3.4. Sustained impact of the FSL training (Early group only)

As described above, an additional 4-week post-training survey was completed by 133 (80%) leaders and 458 (57%) workers in the early intervention group only. All leader-reported outcome variables improved significantly from 2- to 4- weeks after the training, including crew-reporting of safety-related conditions (see Fig. 3 and Supplemental Table S3). These findings confirm hypothesis 3 a-c. However, the worker-reported outcomes did not show a significant change (see Fig. 4 and Supplemental Table S4). Thus, hypothesis 4 a-d is not confirmed.

outcomes from 2- to 4-weeks after the early group leader's FSL training (1–5 Likert response scales).

4. Discussion

The goal of this study was to assess the degree to which the Foundations for Safety Leadership (FSL) training affected a number of construction leader and worker-reported outcomes. Our findings indicate that at 2- and 4-weeks after participating in the training the leaders showed an increased understanding of the FSL safety leadership skills as well as an improvement in their use of the safety leadership skills and safety practices. These results are supported by findings from earlier studies conducted in other industries and in other countries, which found that providing safety leadership training to those in management or supervisory positions can have a positive impact on a variety of leader safety-related outcomes (Mullen & Kelloway, 2009; von Thiele Schwarz et al., 2016).

The post-training outcome variable improvement, however, was not seen in the worker data. We suggest at least three possible reasons for these results. First, the study's 2- and 4-week (early group only) follow-up may have been too short of a time period for the leaders to fully incorporate and practice the skills and for crew-members to notice and acknowledge changes in the leader's actions. Others who found that safety leadership interventions improve worker-reported safety climate and safety leadership outcomes measured worker outcomes months after their intervention (Bronkhorst et al., 2018; Mullen & Kelloway, 2009; von Thiele Schwarz et al., 2016). As Kelloway and Barling (2010) note, leadership development interventions are difficult to evaluate as their effects are often indirect and delayed. Ideally, we would like to have collected data several months after the FSL training to allow leaders time to integrate the key concepts presented in the FSL training into their workday practices, and also for their workers to observe the changes. This is particularly true for safety climate, as these perceptions take time to be internalized and expressed. Indeed, when creating the FSL we deliberately called it the "Foundations" for safety

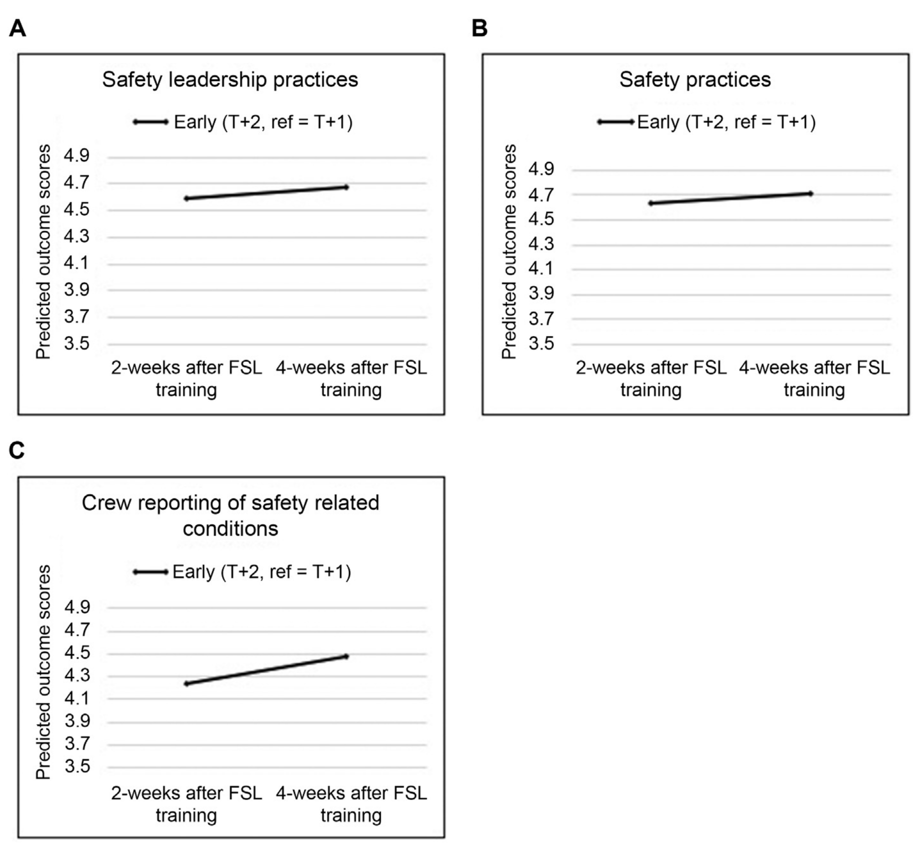

Fig. 3. Results of linear mixed models - predicted average scores for leader reported outcomes from 2- to 4-weeks after the early group leader's FSL training (1–5 Likert response scales).

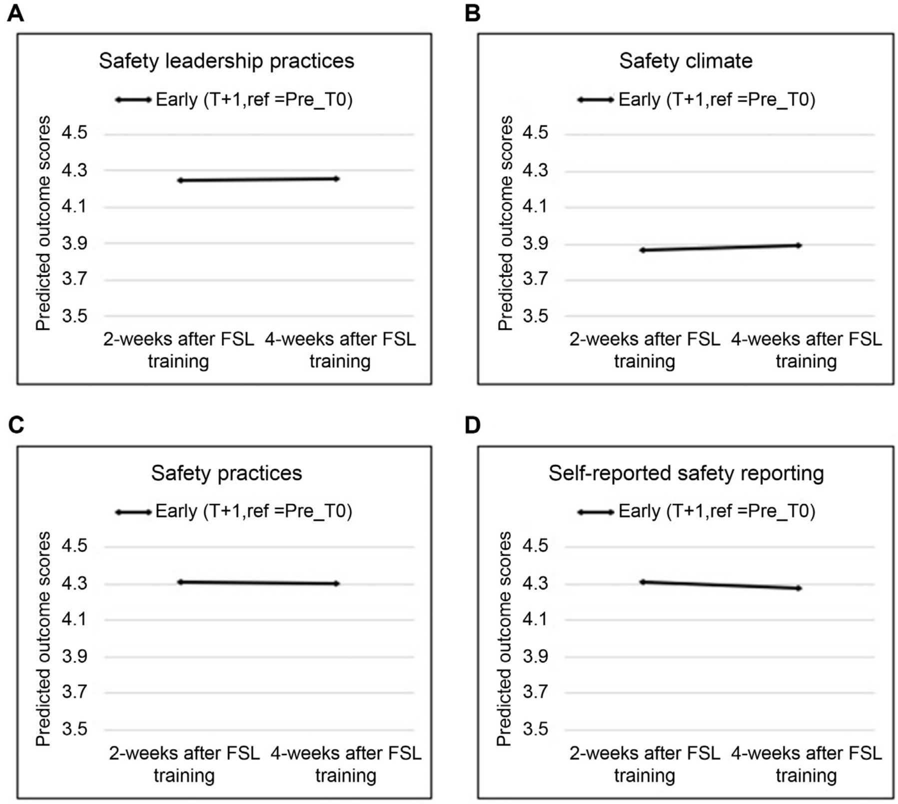

Fig. 4. Results of linear mixed models - predicted average scores for worker reported outcomes from 2- to 4-weeks after the early group leader's FSL training (1-5 Likert response scales).

leadership because we knew that just taking the training would not automatically turn the trained foreman or lead persons into effective safety leaders. Rather they would need to practice the skills for a period of time for them to become internalized and automatic.

Second, to achieve the study goals, in particular having OSHA incorporate the final training into their 30-h course as an elective, various design-decisions related to length and content had to be made during the development phase (see Goldenhar et al., 2019, in this issue for more detail. The OSHA 30-h includes many safety and hazard recognition topics that must be covered in a specified amount of time. However, trainers are given some discretion on which electives they want to teach. All of the OSHA trainers on the curriculum development team agreed that the elective leadership training module we were developing had to be less than 3 h (2.5 at the most) or trainers would not select it as one of the electives to teach and, even more important, OSHA would likely not agree to include it in the 30-h course. Also, given the fast-paced nature of construction, with time being a critical and often defining element, many companies would likely not find it feasible to implement a longer module into their on-going training efforts. Thus, while the 2.5 h FSL training alone may be intensive enough for some, not all leaders will be able to immediately apply the training concepts to their jobs and make meaningful changes to their leadership practices. Mullen and Kelloway (2009) suggest combining training with personalized ongoing feedback for a year to facilitate maintenance of safety leadership practices. Thus, moving forward it may be valuable to incorporate additional coaching or 360 degree feedback into an updated FSL (Kines et al., 2010; von Thiele Schwarz et al., 2016; Zohar & Luria, 2003).

Finally, the flow of workers coming and going from a jobsite over the course of the study resulted in a large amount of missing worker data, which is another likely contributing factor to the non-significant worker results (Sparer et al., 2015). We were unable to collect the surveys from approximately 40% of our worker sample, including for one company where we were not able to collect any worker data. Thus, we did not meet the sample size requirement of 1000 workers, which limited the study's statistical power to detect any change in measured constructs from before to after the FSL training. It is likely that our study design strategy to recruit companies rather than jobsites actually increased the amount of follow-up data we were able to collect because we worked directly with the company contacts to find out the workers' assigned location. Nevertheless, many workers were not at the jobsite when we arrived due to being relocated to other jobsites, layoffs, or other absences.

Despite some of the non-significant findings from the survey data, our study participants and others who have been using the FSL since its official rollout January 1, 2017, have told us that the FSL fills a needed skills gap and they have embraced it as a step towards exposing front-line leaders to safety leadership skills. Indeed, as of January 2019, over 60,000 individuals have experienced the FSL training either as part of an OSHA 30-course or as a company or union stand-alone training. Many of these users have recognized a need to encourage leaders to practice the safety leadership skills through on-the-job practice, refresher trainings, and support from upper management; activities that others have used in prior leadership improvement studies. In response, we have developed several tools to help reinforce the learned leadership skills after the training is over. Specifically, a 16-page handbook provides users with a brief synopsis of the leadership skills, how to implement them, a self-assessment to determine what skills they are currently practicing, and a personal leadership skill improvement plan. There is a tool box talk for each of the FSL leadership skills, which leaders can use during morning huddles or as part of new employee orientation. To further enhance the training program, a contractor-user suggested creating a “Create your own Scenario” worksheet that companies, leaders, and trainers can use to develop new scenarios based on their own trade and/or experiences. In the future, researchers could evaluate the benefit of combining the FSL training module with these additional resources in improving safety leadership and jobsite safety climate. All FSL teaching materials and additional resources can be downloaded on CPWR's website for free at https://www.cpwr.com/foundations-safety-leadership-fsl (CPWR: The Center for Construction Research and Training, 2018).

4.1. Strengths & limitations

The study has a number of strengths. The FSL training, developed with extensive stakeholder input, addressed an identified construction industry need to enhance supervisor's leadership skills as an important way to improve job site safety climate and safety outcomes. While some large construction companies and labor unions have started to provide leadership training for employees, the FSL program provides safety leadership skills to all frontline construction leaders regardless of their affiliation. Even without hard evidence, the FSL is already being embraced by the industry. Furthermore, a number of General Contractors and other companies are now requiring that the FSL module be a required part of the OSHA 30-h course for their foremen, and not merely an elective. This is a testament to the need and its observed usefulness to promote job site leadership skills.

The wide range of trades, geographical locations, sizes, and union membership status of participating companies in this evaluation study suggests that the findings are generalizable. Additionally, the switching-replications study design allowed us to compare intervention and control group data while being able to provide the training to all leaders, which strengthened our relationship with company partners.

One limitation is the reliance on self-reported survey data. The initial intent to conduct safety audits on each jobsite as an additional and more objective outcome measure proved infeasible. However, many of the self-reported metrics have been validated in the construction and other industries within theoretical and behavioral frameworks supporting their use here. Another limitation was the amount of missing worker follow-up data, which may have resulted in an inability to accurately assess changes in worker-reported outcomes from before to after their leaders participated in the FSL training. In an effort to address this challenge, worker responses within the work crews were averaged, which was supported by the ICC descriptive statistics (Zohar & Polachek, 2014).

4.2. Possible future FSL-related activities

Additional training interventions with similar safety leadership messages could be designed that draw upon shared or distributed leadership theory, which has been linked to safety outcomes (Bienefeld & Grote, 2014). Shared leadership theory posits that leadership can emanate from multiple members of a team when there is a shared purpose, social support, and voice (Carson, Tesluck, & Marrone, 2007). An integrated safety training that targets leaders at all levels, including workers, could be designed to address conflicting role demands, production pressures, and unsupportive environments that can affect one's ability to be an effective safety leader (Conchie, Moon, & Duncan, 2013; Lee et al., 2018).

Beyond leadership training, researchers argue that a systems approach is needed to improve safety climate (Murphy, Robertson, & Carayon, 2014). Indeed, in a recent review of the literature, Lee et al. (2018) suggested that the next step in safety climate intervention research is to focus on improving the organizational as well as technical aspects of the work environment. In the future, it will be important to evaluate the effect of including the FSL alongside other safety climate improvement interventions.

Finally, additional evaluation metrics such as safety audit data, injury data, and workers' compensation costs could be used to expand our understanding of the FSL training's effect on both leading and lagging indicators of worker health and safety.

5. Conclusions

In 2013, construction industry stakeholders identified a need for their foremen and other frontline leaders to acquire the knowledge and skills to become more effective jobsite safety leaders. The Foundations for Safety Leadership (FSL) was designed to meet that need. While there are a number of study limitations, we were able to provide evidence that leaders report using and improving the leadership skills they learned 4-weeks after participating in the FSL training. More research is needed to understand the effect of the FSL on worker-reported outcomes.

6. Practical applications

The Foundations for Safety Leadership (FSL) program fills an identified need for construction frontline supervisors to learn and practice critical safety leadership skills on the jobsite. It has already reached over 60,000 leaders and has the potential to reach over 100,000 each year during either an OSHA 30-h or a stand-alone course.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsr.2019.04.010.