Promoting Construction Supervisors' Safety-Efficacy to Improve Safety Climate: Training Intervention Trial

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Abstract: Hispanic workers may be more likely to experience a deficient safety climate on construction worksites and it may account for their disproportionate injury rates. As part of a large study, the authors developed and implemented a 5-h training program to improve construction supervisors' safety-efficacy, in order to enhance the safety climate on construction worksites. The training program covered fall prevention, silica exposure, leadership, communication, and safety planning. This study evaluated pretraining and posttraining changes and safety-efficacy six months posttraining. A total of 118 supervisors, contractors, and workers from more than 50 construction firms in Massachusetts attended the training. Statistically significant improvements were observed in participants' safety knowledge, skills, and attitudes. Six-months postintervention, 58% of supervisors, contractors, or both, perceived that the training contributed "a lot" to their ability to communicate effectively with Spanish-speaking workers, to take on a safety leadership role (52%), and to conduct effective training (62%). This study determined that when supervisors perceive that they have the knowledge, skills, and confidence to make changes, they may better fulfill their role as a safety leader. Construction supervisor training courses might be revised to include leadership and effective communication topics. **DOI: 10.1061/(ASCE)CO.1943-7862.0001330.**

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Introduction

The construction industry is one of the largest and most dangerous employment sectors in the United States (Dong et al. 2013, 2009; Menzel and Gutierrez 2010). During 2013, there were 828 fatal work injuries in construction with falls to a lower level accounting for 35% of those fatalities (BLS 2014). Hispanic (or Latino) construction workers experience disproportionate rates of injuries and deaths on construction sites (BLS 2014). These high rates and disparities have led investigators and the authors of this study to research both causes and solutions (Arcury et al. 2012a; Forst et al. 2013; Menzel and Shrestha 2012; Williams et al. 2010).

The construction sector faces inherent challenges in achieving safe worksites, including highly variable, risky, and changing worksites; short-term job and employment contracts; production pressures; and multiemployer worksites (Lingard and Rowlinson 2005; Loosemore and Andonakis 2007). Safety leadership is necessary to confront these physical and organizational challenges to achieve safer sites despite inherent risks. Strong supervisor safety leadership has been identified as the key factor in determining the presence or absence of safety on construction sites (Kapp 2012). Safety leadership contributes to a complex variety of interrelated dimensions known as positive safety climate (Kines et al. 2010; Mohamed 2002; Zohar 2010).

The majority of companies in the construction sector are small businesses with few or no permanent employees; also small firms face particular challenges in achieving positive safety and health conditions, because they often lack dedicated and well-resourced safety professionals on their staff who could serve as strong safety leaders (Lingard and Holmes 2001). Competitive pressures and layers of contracting increase the challenges of implementation of health and safety practices in small companies (Loosemore and Andonakis 2007). These firms experience a disproportionate share of injuries in the construction sector, despite under-reporting (Dong et al. 2011). Construction safety experts have also noted that small firms experience less safety standards enforcement. Their workforce also differs from larger firms; employees are less likely to be well-trained, speak fluent English, or be employed directly by the firm (CPWR 2013; Forst et al. 2013; Lingard and Yesilyurt 2003).

Several investigators have explored worker perceptions of the factors behind the disparities experienced by Hispanics in construction and have found that Hispanic construction workers view their work environments as hazardous and hostile to safety measures that overcome those hazards (Jorgensen et al. 2007; Marin et al. 2015; Roelofs et al. 2011). They, more than other workers, perform more hazardous tasks, face greater production pressures, are subject to disrespectful attitudes and intimidation, and have fewer means to speak up (Menzel and Gutierrez 2010; Roelofs et al. 2011). Undocumented immigration status, lack of formal technical and safety training, prior experiences of retaliation, and a desire to retain employment and be rehired, may also influence workers to tolerate unsafe conditions (Flynn et al. 2015; Menzel and Gutierrez 2010; Roelofs et al. 2011). For Hispanic workers, language or cultural differences with their employers are not viewed as contributing factors due to the presence of bilingual coworkers and the ability of supervisors to carry out production-related mandates despite language and cultural differences with workers (Roelofs et al. 2011). In short, Hispanic workers may be more likely to

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experience a deficient safety climate which may account for their disproportionate rates of injury.

Injuries could be reduced in the highest risk construction worksites by targeting workplace factors that are both modifiable and efficacious in improving safety climate. The techniques of preventing falls are well understood, feasible, and often required. The Occupational Safety and Health Administration (OSHA) Fall Prevention Standard (OSHA 29 CFR 1926.501) directs employers to utilize well-characterized methods, such as minimizing work at heights and proper ladder-use 84 techniques (OSHA 1995). It also directs employers to use safe ladders, scaffolding, guard rails, and fall arrest systems when employees face a risk of a fall from a height of 1.8 m (6 ft) (Becker et al. 2001). This standard also requires worker training in a manner understandable by the workforce according to the OSHA Training Standards Policy Statement (OSHA 2010a, b), and supervisor competence in preventing falls. However, as mentioned previously, compliance with these regulations is far from universal and regulatory enforcement is limited, particularly in the case of small residential construction contracting companies which frequently employ Hispanic workers (Dong and Platner 2004). The authors hypothesized that injuries among Hispanic workers in construction could be reduced by improving the potential for effective safety leadership by construction supervisors in small construction companies. Although it would not be possible to design an intervention to test this hypothesis due to limited resources and data sources, it could be feasible to design a study to measure a directly related intermediate outcome: improved self-reported safety leadership. A training intervention called Leaders in Safe Construction (LISC) was developed as part of a larger community-based participatory research project, Protección en Construcción (PenC): The Lawrence Latino Safety Partnership. LISC aimed to train construction supervisors in safety leadership and planning, fall prevention techniques and requirements, and communication strategies. The goal of the training intervention was to help supervisors achieve the knowledge, skills, and attitudes necessary to create a positive safety climate on small firms' worksites. Protección en Construcción was conducted through collaboration of the Lawrence Mayor's Health Task Force, Laborers International Union of North America Local 175, Lawrence Community Connections, and the Department of Work Environment at the University of Massachusetts Lowell.

Conceptual Framework

Safety Climate Model for Hispanic Construction Workers

Safety climate captures work-group perceptions regarding the importance given to safety by management in comparison to other organizational priorities (Guldenmund 2010; Huang et al. 2011; Jorgensen et al. 2007; Zohar 2008, 2010). Construction workers in general, but Hispanics specifically, report a negative safety climate in their workplaces which can be understood as an indicator of the poor safety conditions experienced by workers in this sector (Arcury et al. 2012a; Marin et al. 2015). Zohar suggests that the development of industry-specific climate scales should be encouraged as such development is likely to identify new, context-dependent targets of climate perceptions in respective industries (Zohar 2010). Jorgensen has adapted the safety climate model to a context specific to Hispanic workers (Jorgensen et al. 2007).

Marin et al. (2015) proposed a model built upon Jorgensen's and comprises six dimensions of safety climate relevant to the construction industry and, in particular, to the worksites where Hispanics work (social support, safety over productivity, training, roles and responsibilities, nonretaliation, and protective equipment). This model proposes two new dimensions, social support and nonretaliation, that have not been previously explored in relation to construction safety climate. Social support assesses the extent to which respectful relationships and supervisor and co-worker support are established practices in the workplace. Non-retaliation assesses workers' perception of job threats as a result of safety-related behavior.

Safety climate research has focused on deriving a set of safety climate dimensions able to capture workers' perceptions in relation to injury rates (Gillen et al. 2002; Huang et al. 2011; Kines et al. 2011; Mohamed 2002). However, this training intervention is among the very few examples of interventions designed to improve safety climate by addressing the root causes of poor safety conditions that lead to the higher injury rates experienced by construction workers. Important themes of previous focus group findings (Roelofs et al. 2011) and the results of the safety climate survey (Marin et al. 2015) were translated into a safety climate intervention to improve specific aspects of the construction site in order to reduce injuries and illness among Hispanic construction workers.

Theory of Change

The LISC intervention is based on previous assessment of the need for and the possibility of positive modification of the factors presented in the Hispanic Construction Worker Safety Climate Model (Marin et al. 2015). Additionally, supervisors are the workplace actors with power to influence the conditions that could lead to a reduction of hazards at their source. Field supervisors' safety commitment and leadership have been highlighted as fundamental elements to improve worksites' safety performance (Conchie et al. 2013; Hardison et al. 2014; Sokas et al. 2009). Improvements in Hispanic construction workers' safety knowledge after training have prompted better safety practices in the workplace (Ochsner et al. 2012). However, the lack of reinforcement by supervisors reduces the reach and sustainability of worker training achievements (Sokas et al. 2009). Additionally, whereas worker training to enhance safety knowledge, skills, and positive safety attitudes is essential, it may not readily translate into safer conditions on construction sites. For example, carpenter apprentices have explained in focus groups that they have been trained to have three extension ladders to move boards, but that "nobody does this because the ladders are never there" (Lipscomb et al. 2008).

The leadership practices of supervisors from workplaces with a strong safety climate have been associated with higher safety compliance behavior by employees (Kapp 2012). Safety leadership practices may manifest in multiple ways, but one of the most powerful is communication between supervisors and workers about safety, including managements' safety priorities and workers' safety performance (Conchie et al. 2013). Thus, field supervisors are the main target of this intervention given their role as liaisons between top management and workers and their influence over site safety (Dingsdag et al. 2008). Motivated and empowered supervisors with the knowledge, attitudes, and skills to create safe worksites, i.e., leaders in safe construction, are the key to the improvement of construction safety climate and the reduction of injuries.

Safety-Efficacy: Knowledge, Skills, and Attitudes to Create Positive Safety Climate

The framework for developing, implementing, and assessing the LISC intervention is shown in Fig. 1. Based on formative research conducted previously, this study proposed that through the LISC supervisor training, the gaps in supervisors' knowledge of fall prevention requirements would be filled; skills in identifying

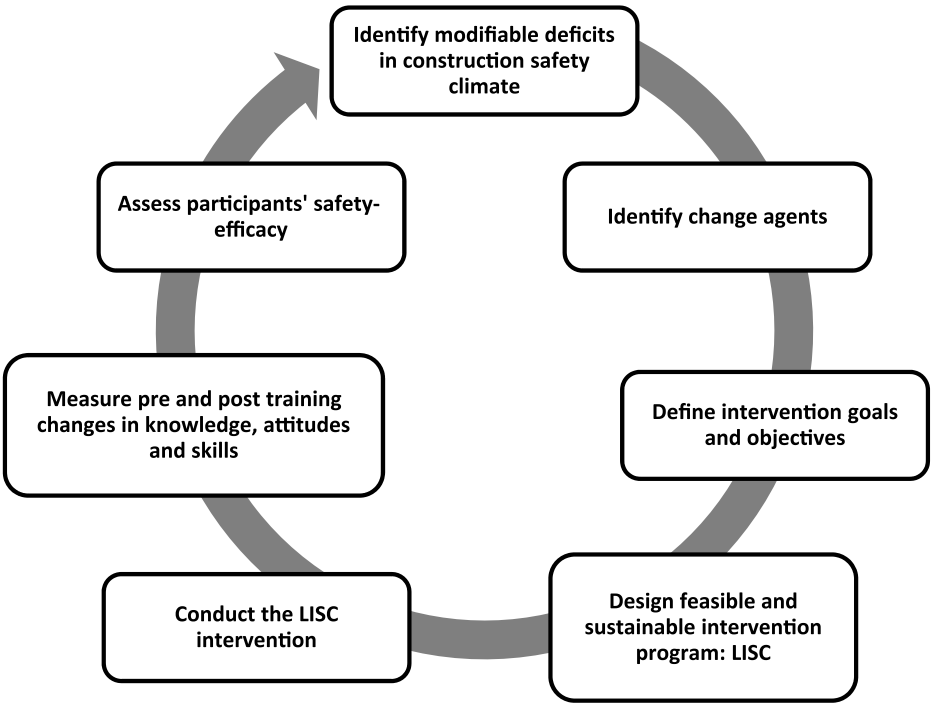

Fig. 1. Framework for implementing and assessing LISC intervention for residential construction

and remedying hazards and communicating with employees would be enhanced; and supervisors' ambition and confidence that their sites could and should improve would be bolstered. The intervention sought to inspire supervisors to direct with respect, to take responsibility for safety, and to feel confident that their actions would lead to positive change. In short, this research aimed to improve construction supervisors' sense of self-efficacy in enhancing safety despite production challenges.

Self-efficacy is a concept adopted from the field of health promotion. Self-efficacy refers to a person's belief that he or she is capable of performing a particular task successfully (Bandura 1977). This concept is broadened here to include not only this sense of having the knowledge and skills to perform a task, but also the confidence and desire that such knowledge and skills can translate into positive changed conditions outside of oneself. For the purposes of this study, safety-efficacy refers particularly to this combination of safety knowledge, skills, and attitudes and it is hypothesized that through a safety leadership training course, supervisor safety-efficacy could be enhanced in order to improve construction safety climate.

Development and Description of the LISC Training Intervention

This study utilized a process consistent with the principles of community-based participatory research (Minkler et al. 2003; Petersen et al. 2006) to develop, implement, and assess the LISC training intervention which took place between November 2011 and December 2012 in Lawrence, Massachusetts.

The intervention was performed by researchers of the University of Massachusetts in collaboration with the Northeast Builders and Remodelers Association of Massachusetts (NEBA) and a local branch of the National Association of Home Builders (NAHB), with the assistance of a local lumber yard, and with community organizations, media, and government agencies that formed the networked base of this project.

The authors designed the LISC 5-h training intervention directly in response to results of the safety climate analysis described in a previous study as the Hispanic Construction Worker Safety Climate Model (Marin et al. 2015). Using formative research, the analysis identified that poor safety climate affects construction workers in general but especially Hispanic workers. Therefore, although the LISC program was designed to intervene in the root causes of negative safety climate experienced by Hispanic construction workers, the results apply to all construction workers. The content and training materials were drawn from the needs assessment represented in the six dimensions of the Hispanic Construction Worker Safety Climate Model (Fig. 2), OSHA requirements, and suggested best practices from the literature. The training program contained modules covering fall prevention, silica exposure, leadership and communication, and safety planning (Fig. 3). The LISC 5-h training program emphasized active learning instructions to improve skills to implement prevention strategies and change work practices.

Researchers developed practical learning objectives targeted to the understanding of construction industry realities. In each session, instructors used short illustrated lectures, safety videos (OSHA e-tools), hands-on demonstrations, and small group case studies to operationalize the key concepts and engage participants in frank and meaningful discussions regarding challenges and opportunities to apply learned knowledge and tools in their day-to-day experiences. Finally, facilitators encouraged participants to write down practical strategies they felt they could implement in their current construction sites after the training.

Training modules were designed to allow participants to either take each one individually or the entire 5-h program in one sitting. The training was offered in English and Spanish, at different days and times, including Saturdays, and at several locations in Lawrence, MA and surrounding areas. In order to meet the needs of the supervisors, attract participants, and provide for the long-term sustainability of the training program, the LISC program was approved for five credits toward the 12-h continuing education

Fig. 2. Elements of the LISC construction supervisor training program addressing dimensions of Hispanic Construction Worker Safety Climate Model proposed by Marín et al. (2015)

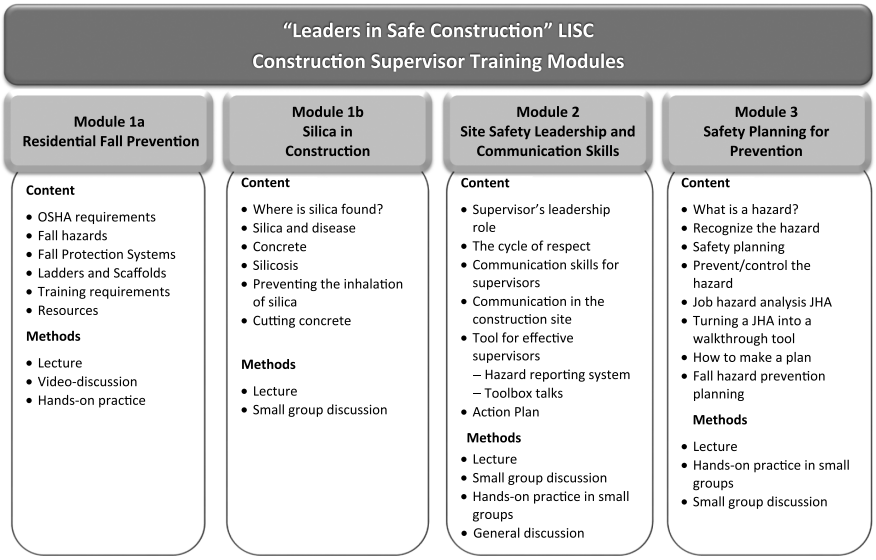

Fig. 3. Training modules for the LISC construction supervisor training program

requirements of the Massachusetts construction supervisors' license renewal. The research protocol and instruments were approved by the University of Massachusetts Lowell Institutional Review Board.

Recruitment

This study took advantage of the community research network to form a recruitment team comprising of staff from the local union, a community organization, and a community members' outreach team. The recruitment team worked in partnership with the City of Lawrence, the NEBA, a local training center, and a local lumber yard to recruit contractors and supervisors to participate. The recruitment process comprised a media marketing strategy including flyers, banners, participation in local radio and community broadcast shows, regular publication of technical articles in a local Spanish-language newspaper, and fall protection equipment demonstrations in the local lumber yard, to attract and invite potential participating contractors and supervisors. The outreach team observed ongoing residential construction projects in the Lawrence area and invited these contractors to join the LISC program. The LISC program and the scheduled training sessions were also publicized during meetings of Lawrence city contractors, union members, and NEBA. Interested candidates were contacted to alert them to the purpose of the training, benefits, and schedules. The training sessions were conducted in the facilities of the PenC project partners.

Evaluation and Impact Assessment

The intervention and assessment of its impact were evaluated in two ways: a pretraining and posttraining questionnaire and a 6-month postintervention follow-up survey. The training evaluation collected demographic information as well as responses to 21 questions (true, false, and don't know) regarding participants' safety knowledge, attitudes, and skills at the beginning of and following each module. The wording was reversed in a positive (or negative) voice on some questions in order to get a stronger and more valid measure (e.g., jobs lasting less than two weeks do not need fall protection systems; if workers nod agreement, I know that they have understood safety instructions; the best way to protect workers is to provide them with personal protective equipment).

Table 1. Demographic Data from Training Participants ($n = 118$)

Variable	Group	n	%
Primary job title	Foreman or supervisor	87	74
	Contractor	24	20
	Worker	7	6
Company size	1–5 employees	56	47
	6–10 employees	22	19
	More than 10 employees	15	13
	No employees	20	17
	Not reported	5	4
Seniority in construction	Less than 1 year	5	4
	1–5 years	19	16
	6–10 years	19	16
	More than 10 years	58	49
	Not reported	17	14
Type of construction work	Residential new construction	15	13
	Residential renovation and repair	52	44
	Commercial renovation and repair	3	2
	Any type	33	28
	Not reported	15	13

Table 2. Results from LISC Training by Language Offered and Content Module

Training module	Total attendees (n =)	Attendees by training language: English n (%)	Attendees by training language: Spanish n (%)
All modules	61 (52%)	26 (43)	35 (57)
Fall prevention (only)	11 (9%)	3 (27)	8 (72)
Communication and leadership (only)	30 (25%)	30 (100)	0
Safety planning (only)	16 (14%)	16 (100)	0
Total participants	118	75 (64)	43 (36)

These self-administered questionnaires were anonymous and were not linked to a participant. The 6-month follow-up questionnaire comprised 22 questions and was administered by a research assistant by phone. Training participants who reported not having worked in the construction industry during the months following the training were not included in the evaluation.

Data Analysis

Data from written pretraining and posttraining evaluations were double entered in *Microsoft Access* and extracted for data analysis into a statistical package for social sciences statistics (*SPSS Statistics 21*). Questions were coded in broad categories such as knowledge, attitudes, and skills. Within each of the subgroups were questions about fall prevention, silica exposure, leadership and communication, and safety planning. Descriptive statistics were conducted. To minimize the impact of the small sample size, bootstrapped paired-sample t-tests were performed to determine significant differences in participants' knowledge, attitudes, and skills before and after training. Cohen's coefficients were calculated to estimate the size effect of pre-post change. For the 6-month follow-up survey, items were sorted into six safety-efficacy dimensions: (1) effective communication; (2) fall and silica knowledge; (3) fall and silica prevention; (4) leadership; (5) safety planning; and (6) workers' training. The proportion of responses in each Likert scale point was calculated using *SPSS Version 21*.

Results

Description of Participants

A total of 118 foremen, supervisors, contractors, and workers from more than 50 construction firms across the Greater Lawrence Area attended the construction supervisor safety training. Participants were from small companies and 53% reported more than five years of experience in the construction industry (Table 1). Sixty-one participants completed all of the modules (52%) and 57 attended at least one of the training modules (Table 2). For the 6-month follow-up survey, 65 (59%) safety training participants were successfully contacted. Among those contacted, 21 (32%) refused to respond to the survey or were not working in the construction industry at that time. Forty-four responded to the follow-up survey. The final 6-month follow-up sample consisted of 32 construction supervisors or contractors, as 12 of the respondents had not had supervisory responsibilities in the prior six months.

Safety Knowledge, Attitudes, and Skills Pre-Post Assessment

Overall, most dimensions showed statistically significant differences in participants' safety knowledge, attitudes, and skills before and after training (Table 3). There was a significant improvement in participants' overall safety knowledge before and after the training. When this dimension was disaggregated into knowledge related to fall prevention, silica exposure, and leadership and communication, there was a statistically significant difference before and after training at $p < 0.05$. Knowledge regarding silica exposure showed the highest change in this dimension. Change in safety planning knowledge before and after training was not statistically significant. There were also statistically significant positive changes in participants' attitudes related to fall prevention and

Table 3. Pre-Post Evaluation Survey Results and Effect Size by Training Parameter and Content Using Bootstrapped Paired-Sample t-Test

Training parameter	Content	n	Pretraining Mean (±SD)	Posttraining Mean (±SD)	Mean difference pre-post	p-value	Cohen's term d[a]
Knowledge	Fall prevention	53	0.54 (0.22)	0.61 (0.21)	0.11	0.050	0.50
	Silica exposure	52	0.53 (0.23)	0.81 (0.20)	0.28	0.001	1.22
	Leadership and communication	63	0.73 (0.29)	0.94 (0.13)	0.21	0.001	0.72
	Safety planning	53	0.47 (0.42)	0.47 (0.42)	0.00	0.958	—
Attitudes	Fall prevention	53	0.90 (0.25)	0.97 (0.12)	0.07	0.044	0.28
	Leadership and communication	63	0.78 (0.31)	0.90 (0.24)	0.13	0.021	0.42
	Safety planning	53	0.56 (0.47)	0.58 (0.47)	0.20	0.764	0.43
Skills	Fall prevention	53	0.75 (0.32)	0.96 (0.13)	0.22	0.002	0.69
	Leadership and communication	63	0.68 (0.41)	0.94 (0.17)	0.25	0.001	0.61
	Safety planning	52	0.60 (0.30)	0.77 (0.25)	0.17	0.001	0.57

[a]Cohen's term d (effect size): small 0.2; medium 0.5; large 0.8; very large 1.3.

Table 4. Six-Month Follow Up: Participants' Safety-Efficacy

Safety-efficacy dimensions	Number of questions	Contractors/supervisors ($n = 32$) A lot (%)	Some (%)	A little (%)	Nothing at all (%)
Effective communication	2	55	38	5	2
Did the training make a difference in how effectively you communicate about safety?	—	53	44	3	0
Has the training helped you to improve communication with Spanish-speaking workers?	—	58	29	8	4
Fall and silica knowledge	4	70	30	0	0
How much did you learn about fall protection from our training?	—	75	25	0	0
How much did you learn about fall protection equipment from our training?	—	75	25	0	0
How much did you learn about OSHA's fall protection requirements from our training?	—	60	40	0	0
How much did you learn about silica hazards from our training?	—	71	29	0	0
Fall and silica prevention	5	62	36	3	0
Did the training make a difference in preventing falls in your worksite?	—	59	34	6	0
Did the training play a role in your decision to purchase fall protection equipment?	—	40	60	0	0
How confident do you feel in your ability to comply with OSHA's fall prevention requirements?	—	75	25	0	0
Did the training positively improve your ability to comply with fall prevention requirements?	—	56	44	0	0
Did the training make a difference in preventing silica exposure in your worksite?	—	66	28	6	0
Leadership	2	52	48	0	0
Do you feel that you are a leader for safe construction?	—	50	50	0	0
Did the training positively impact your safety leadership role?	—	53	47	0	0
Safety planning	1	53	44	3	0
Did the training help you to plan your work tasks to reduce safety issues?	—	53	44	3	0
Workers' training	2	64	23	6	6
How often have you conducted fall prevention training with workers on your worksite?	—	66	16	9	9
Did the information you learn from the training help you to train your workers?	—	63	31	3	3

leadership and communication. Participants reported significantly improved safety skills ($p < 0.001$) such as fall prevention, leadership and communication, and safety planning.

Construction Supervisors' Safety-Efficacy

The items on the 6-month follow-up survey are described in the framework of the proposed concept of safety-efficacy (Table 4). Safety-efficacy results revealed that a high percentage of supervisors, contractors, or both, perceived that the construction supervisor training contributed a lot to their ability to reduce fall and silica hazards; communicate effectively with workers, in particular with Spanish-speaking workers; take on a safety leadership role; and conduct training with workers. Participants reported a lot of confidence in their knowledge even six months after participating in the intervention. Seventy-five percent of participants surveyed reported a lot of confidence in their ability to comply with OSHA's fall prevention requirements. Sixty-five percent also reported an increase in the frequency of training and 63% reported that the knowledge acquired during LISC training was highly useful in training their workers. Participants reported a lot (50%) or some extent (50%) of self-reliance in their role as a safety leader in the construction site and that the LISC training had a positive impact in becoming safety leaders.

Discussion

The first goal of this study was to evaluate the effect of the safety leadership intervention program in enhancing small firms' construction supervisors' safety knowledge, attitudes, and skills. The results showed that the 5-h construction supervisor safety training resulted in an improvement in participants' safety knowledge, attitudes, and skills related to fall prevention, communication, leadership, and planning. Although most of the supervisors trained through this intervention reported some level of safety knowledge, attitudes, and skills before taking the training session, the pre-post evaluation showed a large effect size in eight of the ten content themes. Improvements in the learning dimensions were identified immediately after completion of the training intervention. The size of effects ranged from 0.49 to 1.90, suggesting that the LISC supervisor training was effective in improving participants' safety learning, and especially their safety leadership skills.

The importance of safety knowledge as well as communication and effective leadership skills in construction supervisors, particularly in those working with Hispanic workers, has been identified in previous studies (Arcury et al. 2012b; Hardison et al. 2014; Harrington et al. 2009). Through the LISC program, this study focused on filling the construction supervisors' training gap regarding technical, cultural, and leadership competencies. These findings showed that the LISC training had a positive effect on construction supervisors' knowledge regarding fall prevention requirements, enhanced safety communication skills, increased worker-supervisor safety interactions, as well as contributed to supervisor self-identification as workplace safety leaders. Few interventions have targeted construction supervisors as potential safety leaders. However, these results are consistent with Kaskutas et al. (2013), who identified more interactive toolbox talks, better compliance with fall protection requirements, and high emphasis in hazard recognition in the most dangerous daily tasks after training construction foremen (Kaskutas et al. 2013).

Worker training interventions that addressed similar dimensions of safety climate have also reported significant impact on participants' safety knowledge and attitudes after hands-on training programs (Sokas et al. 2009), more efficacy to make changes in unsafe workplace conditions (Becker and Morawetz 2004), and improvements in positioning themselves as safety leaders in the construction sites (Ochsner et al. 2012). Likewise, Robson et al. (2012) concluded that occupational health and safety (OHS) training interventions are effective in improving participants' attitudes and behaviors. Although contrary to these findings, Robson et al. (2012) point out that the evidence is inconclusive to confirm the effectiveness of OHS training on improving knowledge.

Although pre-post training differences can be considered small, the largest changes were identified in the effect that the LISC training had on improving participants' applied skills. Whereas safety planning knowledge did not show any change before and after training, statistically significant improvements were identified in participants' safety planning skills. Similarly, leadership and communication skills had the highest pre-post change. This finding should be considered in updating traditional supervisor training such as OSHA's 30-h training (OSHA 2011) which focuses mainly on learning to recognize hazards but without reinforcing action learning or integrating leadership skills, communication skills, or both, which can contribute to promoting a better safety climate in the workplace. The fact that the training approach used participants' collective experiences to motivate application of training knowledge and provided opportunities for modeling action may have also contributed to these results.

As for measuring medium- and long-term intervention effectiveness, the reduction of injury rates should be the gold standard. However, there are several challenges to utilizing this indicator in small construction businesses. High turnover, short-term projects, or informal employment (Forst et al. 2013) may limit accuracy of lagging indicators. This research introduced the concept of safety-efficacy as a leading indicator to assess participants' willingness to translate the acquired skills into particular actions which the authors previously identified as determinants of workplace safety climate.

At the 6-month follow up, participants self-reported positive impacts in their safety communication with workers and with their Hispanic workers specifically. Although necessary but not sufficient in creating a safe work environment (Murphy et al. 2014), effective supervisor-worker communication is considered as a mainstay in improving workplace safety climate (Kines et al. 2010; Zohar 2002). Effective daily communication and regularly leading training sessions were also some of the positive outcomes reported by participants in this study after six months of training. In addition, supervisors' self-assessed ability to comply with OSHA's fall protection standard is a remarkable achievement of the LISC program given the challenges faced by small firms as noted earlier.

This study showed that participants identified themselves as workplace safety leaders and that the LISC training was essential to their taking on a leadership role. In addition, they reported high confidence and willingness to address the root causes of poor safety conditions experienced in the construction industry, particularly as experienced by Hispanic construction workers. To the authors' knowledge, this study represents the first attempt to enhance supervisors' safety-efficacy which could have a positive impact on reducing injury rates through improved safety climate.

The limitations of the study include the possibility that bias was introduced by the way the intervention was designed, participants were selected, or the information was classified, which may result in overestimation or underestimation of the associations represented by the data. To test the initial impact of the training intervention with respect to learning parameters (knowledge, attitudes, and skills), this study used the traditional pre-post survey evaluation. Although this approach provides the opportunity for concise and direct ways of evaluating learning throughout the training and can more appropriately respond to the limitations of small residential construction businesses, there are potential internal validity threats. Despite this limitation, nonexperimental before-and-after designs are valid to provide evidence for intervention effectiveness particularly for short-term intervention and evaluation period (Robson et al. 2001) as in this study. Secondly, only 30% of the participants were reached for the 6-month follow-up survey. It cannot be determined if this introduced selection bias to the results, however the follow-up rate is consistent with the general high turnover and seasonal characteristics of the small residential construction contractors. Thirdly, social desirability bias may have also occurred when the 6-month follow-up data was collected. The lack of direct field observations after assessing supervisors' self-efficacy does not allow for examination of how supervisors' confidence and desire to change was in fact translated into real changes in the workplace. The resulting bias would most likely overestimate the supervisors' safety-efficacy effect.

Despite these limitations, this study has several strengths. The development of a novel intervention based on deep formative research which allowed addressing contributing causes of a health and safety disparity experienced by Hispanics in one of the most dangerous industries. The approach was theory-driven, but drawn from relevant qualitative and quantitative data and analysis. Other studies have focused on modifying workers' behavior without giving sufficient attention to the determinants of that behavior in the safety climate of the workplace, especially as influenced by supervisors' safety leadership. The focus on modifying the root causes of safety climate through a construction supervisors' safety leadership training that enhances social and technical knowledge, skills, and attitudes, is a unique contribution to the field of safety research. The strengths of this study also include the participation of a large and diverse group of small construction contractors in a defined geographic area (Merrimack Valley). Furthermore, the intervention dose as measured by contact hours in the training and the quality of this engagement, is a clear advantage over other weaker interventions. Thus, despite the inherent challenges of such research, the authors believe that the work described here has advanced both the theory of safety and the potential for its practice under real world conditions.

Conclusion

The construction industry experiences unacceptable rates of injuries and these are disproportionately born by workers in small firms and by Hispanic workers. In order to improve the safety climate in the most recalcitrant and highest risk construction work environments, this research conducted an intervention trial based upon a supervisor safety leadership approach. This study identified modifiable and efficacious safety climate enhancements and it developed the LISC intervention as a dynamic, practical, and advantageous program for small firm construction supervisors. The training program sought more than improved knowledge scores among trainees. The training program also built skills and positive attitudes among supervisors so that their confidence and determination would result in changed conditions on site. These findings suggest that a well-designed and practical training intervention can improve supervisors' safety-efficacy such that they take leadership on sites to improve a variety of complex safety climate factors that are indicative of a worksite where hazards have been reduced.

Whereas the authors hypothesize that that small firms with better safety climate and supervisor safety leadership will have fewer injuries overall, and reduced disparities experienced by Hispanic workers, the study was not designed to demonstrate this association. However, the results provide a convincing foundation for large-scale longitudinal intervention effectiveness research to test the association of improved safety-efficacy and reduced injuries and disparities. The concept of safety-efficacy as a leading safety indicator should be further explored to assess its validity and reliability in the occupational health and safety field, and for its potential for long-term impact on reducing work-related injuries and unfair disparities experienced by Hispanic workers.

The authors encourage the adoption and evaluation of the Hispanic Construction Worker Safety Climate Model and the theory of change for use in research and practice. This theory suggests that supervisors are the most appropriate target of training interventions that their safety-efficacy, an interrelated combination of improved knowledge, skills, and attitudes, can be enhanced through active learning. Trainees' resulting sense of safety leadership will overcome the challenges of achieving a positive safety climate for small construction firms employing ethnically and linguistically diverse workers. In addition, an enhanced safety climate, including the newer concepts of social support and nonretaliation, will result in sustained improvements in safety conditions. The theory presented here differs from those with a primary emphasis on worker training, behavior change, and linguistic and cultural differences between employers and workers, although it incorporates these as dimensions within the safety climate model. Workers cannot be empowered to promote safety and safe behaviors if these are not encouraged and supported by supervisors. The focus on supervisor safety leadership recognizes the opportunities that supervisors have to intervene in on-site conditions and to more effectively influence worker safety behavior and attitudes on an ongoing basis by asserting their own role as worker trainers and communicators of safety. In the absence of large-scale and intense enforcement of safety regulations and worker protection from retaliation, addressing root causes of poor safety climate is a practical and effective target of intervention with promise to reduce work-related injuries and unfair disparities experienced by Hispanic workers over the long-term.

Data Availability Statement

Data generated or analyzed during the study are available from the corresponding author by request. Information about the *Journal*'s data sharing policy can be found here: http://ascelibrary.org/doi/10.1061/%28ASCE%29CO.1943-7862.0001263.

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