



Safety Voice for Ergonomics (SAVE): Evaluation of a masonry apprenticeship training program

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ABSTRACT

Background: Masons have a high rate of musculoskeletal disorders among construction workers and greater than all other industries. Viable solutions to musculoskeletal hazards have been identified by industry stakeholders, yet masons receive minimal ergonomics training. Apprentices, as the next generation of masons, need training and strategies to identify and speak up about ergonomic and safety issues on job sites. To fill this gap, our team developed the Safety Voice for Ergonomics (SAVE) training program.

Methods: The interactive, 7-unit SAVE program was developed specifically for masonry brick and block apprentices. This innovative training contains detailed ergonomics lessons focusing on risk factors and solutions specific to this masonry craft. It also contains lessons that provide communication and problem solving strategies. Evaluation of SAVE employed a randomized control trial designed to assess the effectiveness of SAVE for apprentices over a six-month period.

Results: Our findings demonstrated that compared to controls, SAVE trained apprentices used their safety voice more ($P = .049$) and had greater safety participation ($P = .028$). They adopted more ergonomic practices such as adjusting scaffolding ($P = .016$) and using better body postures ($P = .042$). Apprentices liked SAVE and indicated that it prompted them to change workplace safety behaviors.

Conclusions: SAVE is an effective program, providing needed ergonomic and safety communication training for workers as they begin their trade. The broad adoption of SAVE training by the masonry industry has the potential to empower apprentices, elevate the trade's safety culture, and ultimately reduce musculoskeletal disorders.

1. Introduction

The work of brick and block masons requires repetitive, awkward postures and heavy lifting on a daily basis (Hess et al., 2010). The consequence is that rates of musculoskeletal disorders (MSDs) among brick and block masons in the United States (US) continue to be among the highest among construction trades and greater than those for all industries, with strains and sprains accounting for 65% of all injuries resulting in days away from work (CPWR, 2018). In 2015, masons had a rate of 33.4 overexertion injuries per 10,000 Full Time Equivalents (FTE), with days away from work, compared to 31.3 for all industries (CPWR, 2018). The low back injury rate among masons was 22.0 per 10,000 FTE, compared to 16.2 for all industries (CPWR, 2018, chapters 48 and 49). Masons also report high rates of injuries to other body regions

such as the neck, upper extremities, and knees (Boschman et al., 2012) (CPWR, 2018). These injuries are due to the physically demanding nature of masonry work, including repetitive brick and block placement and saw cutting (Spielholz et al., 2006). They can be disabling, causing masons to leave the trade prematurely (Welch, 2009). Moreover, young workers (15–24 years), including masonry apprentices, have higher rates of workplace injuries than experienced workers (Okun et al., 2016) (CPWR, 2018). Since demand for masons is expected to grow 12% by 2026, (Bureau of Labor Statistics (BLS) accessed 01/26/2019) there is an urgent need to address these high musculoskeletal injury rates and provide effective injury prevention training for masons new to the trade.

Many viable ergonomic solutions for masonry that reduce the risk of musculoskeletal disorders (MSDs) have been identified (Anton et al., 2013) (Hess et al., 2012) (Entzel et al., 2007). Despite the availability of

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these solutions, apprentices in the US typically receive no ergonomic training or have only limited training, such as proper lifting techniques. In the United States, many construction workers learn their craft through a combination of union based apprenticeship programs (versus vocational schools) and on-the-job training. Apprentices, as they embark upon their careers, are an important population on which to focus in-depth ergonomic training, as they learn their trade skills and before they adopt poor work practices. This lack of knowledge about hazards and ergonomic solutions could contribute to continuing high rates of MSDs among masons and therefore must be addressed throughout the trade with widely disseminated, effective ergonomic training.

Ergonomics is not the only content lacking from masonry apprenticeship training. The construction trades are hierarchical: Apprentices are mentored on job sites by older, journey-level workers and supervisors. As such, apprentices face peer pressure to conform to the way things have traditionally been done, whether that is the safest way or not. Apprentices may also find it difficult to speak up about ergonomics and other safety hazards with coworkers and supervisors, or to problem solve when faced with specific hazardous situations. Training programs often lack soft skill training, such as effective communication or “safety voice” to appropriately respond to unsafe work environments and practices. Yet, training addressing soft skills may have a positive health impact for younger workers (Dong et al., 2004). While there is a dearth of studies specific to the benefits of safety communication in construction, other industries, such as health care, have found that “speaking up” about hazards has a positive effect (Sayre, 2012) (Tucker and Turner, 2014).

The aim of the SAfety Voice for Ergonomics (SAVE) program was to integrate evidence-based ergonomic training with communication skill training using appropriate adult learning methods (Mezirow, 1991) (National Institute of Health (NIH), 2005). The SAVE Program was evaluated using a pragmatic randomized controlled trial. The training was designed to provide apprentice masons with detailed knowledge of ergonomic principles and solutions, plus problem solving skills and strategies to speak up about hazards they encounter on the job. Our hypothesis was that ergonomic training combined with safety voice communication strategies would be more effective than no training or ergonomic training alone for improving knowledge, attitude, and behavior relative to ergonomics and using one’s safety voice.

2. Methods

2.1. Study design

Details of the SAVE Program and training intervention evaluation design have been published elsewhere (Kincl et al., 2016). Briefly, apprenticeship training centers were assigned at random to one of three study arms: ergonomic training only (E), ergonomic and safety voice training (ESV), or a control arm with no additional training intervention (C). All consented apprentices within a center participated in that study arm, resulting in a cluster randomized controlled trial (RCT) design. Outcomes were measured with a self-reported questionnaire per apprentice on four occasions: at baseline, at 2-weeks after baseline assessment (post-training for E and ESV groups), and at 3-months and 6-months post-baseline. The resulting overall design was a 3 × 4, training group (E, ESV, or C) by time of measurement (baseline, 2-weeks, 3-months, 6-months) factorial design with repeated measures on the last factor and apprentices nested within apprenticeship programs. The trial was registered on [ClinicalTrials.gov](https://www.clinicaltrials.gov) (NCT02676635).

2.2. Participants

A total of 183 masonry apprentices from 14 International Masonry Institute (IMI) apprenticeship training centers were enrolled to participate in the SAVE study. A list of potential IMI training centers with over six brick and block apprentices enrolled was provided by a member of

the IMI masonry research to practice (r2p) partnership, a masonry stakeholder group that supported SAVE research. From that list 14 centers were recruited. These training centers were then randomly assigned to one of the three intervention arms (E, ESV, or C). All participants were enrolled during attendance at their regularly scheduled apprenticeship skills training, and E or ESV training was conducted during regularly scheduled apprenticeship training. Participants provided written consent to participate via an informed consent form approved by the Eastern Washington University Institutional Review Board. Participants were eligible for inclusion if they were first through third year brick or block apprentices, and were 18 years of age or older. Participants were ineligible if they did not own a cell phone with capability to receive short message service text messages since text messaging was used for communication with study participants throughout participation. They were also excluded if they did not speak and read English, as the SAVE program and evaluation measures were in English. The participation criteria were explained to each group of apprentices during onsite recruitment. Therefore, when asking for volunteers, only two or three apprentices who did not meet inclusion/exclusion criteria did not enroll.

Data from one apprentice assigned to the control condition were removed as he was the single apprentice who completed follow-up measures at his site. Twenty-three apprentices assigned to the E and ESV training arms did not receive the SAVE training following consent and were removed from the sample. An additional 32 apprentices who received the SAVE training did not complete 2-week post-training assessment, and were removed from the sample. The final sample consisted of 127 apprentices from 12 apprenticeship training centers geographically distributed across 12 states (Fig. 1). Participants who completed the 2-week follow up assessment consisted of those in the E group (n = 48 within 5 training centers), the ESV group (n = 52 within 4 training centers), and the C group (n = 27 within 4 training centers).

2.3. Intervention

SAVE primary training materials were developed with input from IMI apprenticeship instructors and apprentices. Each of the seven units was composed of a 12 to 17-min interactive video with pauses for discussions, activities, and quizzes, such that each unit was expected to take about 30-min to complete. Unit titles for SAVE E arm are 1) Introduction to Anatomy and Cumulative Trauma, 2) Awkward and Neutral Postures, 3) Repetitive Postures and Prolonged Lifting, and 4) Ergonomic Solutions. Unit titles for the E with ESV arm also included 1) Safety Responsibility and Communication, 2) Identifying Safety Hazards and Information, and 3) Solving Safety Problems with Solutions.

The training incorporated *blended learning* principles that combined



Fig. 1. Geographical distribution of the masonry apprenticeship training centers where SAVE was evaluated.

traditional face-to-face teaching methods taught by IMI instructors using the units as primary training, with secondary refresher training delivered over several months via text messaging to only the E and ESV groups (Allen and Seaman, 2012) (McKeown et al., 2012) (Liu et al., 2016). The text messages reinforced key concepts taught in the units. A full description of the SAVE text messages and secondary training are published elsewhere (Kincl et al., 2020).

Prior to teaching SAVE, IMI instructors in the E and ESV arms received 3 hours of SAVE train-the-trainer instruction (TtT) from a research team member visiting their training center. During the TtT instruction, an overview of all E or ESV materials was provided, with the majority of the time spent reviewing unit activities and discussions, and answering questions to ensure that instructors were competent with materials. Instructors were asked to conduct the SAVE training within 1-week of receiving the TtT instruction. At the same visit, researchers gave a brief presentation to the apprentices for recruitment purposes. For centers assigned to the C arm, TtT instruction was not provided, but researchers delivered a brief presentation to the apprentices for recruitment. Apprentices who agreed to participate completed the baseline questionnaires. To avoid reactive bias from assignment to the C arm, instructors and apprentices were not informed of assignment to the control condition prior to completion of baseline questionnaires.

In addition to the SAVE unit videos, apprenticeship instructors were provided an instructor manual with detailed teaching instructions for teaching E or ESV. The manual highlighted key points and provided discussion talking points and additional supporting information for each unit. Likewise, apprentices were supplied with a workbook specific to E or ESV that followed each unit, and provided space for the apprentices to take notes and record answers to the quizzes and discussions. All SAVE materials are free to download and use from CPWR (<https://www.cpwr.com>).

2.4. Outcome measures

At baseline, participants reported demographic characteristics, apprenticeship level, and other job history information, as well as self-report functional health and well-being via the Short Form-12v2® health survey (SF-12) (Ware et al., 2010). The SF-12 consists of 12 items that are pooled into eight scales further aggregated into two summary measures, the physical and mental component summary measures (PCS & MCS).

Participants completed baseline questionnaires in the presence of researchers. The subsequent questionnaires were mailed to apprentices with a self-addressed, stamped return envelope. For each completed questionnaire received, apprentices were sent a \$50 Visa gift card. Apprentices who completed the study received a total of \$200. A questionnaire packet with the following components was used for assessment:

Musculoskeletal Symptoms were assessed with the Modified Nordic Questionnaire (MNQ) (Kuorinka et al., 1987). The MNQ is well validated and frequently used for studying work-related MSDs (Bodin et al., 2012) (Nordander et al., 2013) (Parot-Schinkel et al., 2012). The MNQ consists of a diagram of the body with nine anatomical regions highlighted from neck to feet. For each region, participants indicated with a “yes/no” response whether they had a job-related ache, pain, discomfort, or other complaint in each region, in the past week. For any region for which a “yes” response was obtained, the respondent then indicated yes/no whether the complaint prevented them from doing a day’s work and if they sought healthcare for the problem. The total number of body regions for which an apprentice endorsed pain, work prevention, or healthcare utilization was summed per participant.

The National Institute for Occupational Safety and Health (NIOSH), in a systematic review of worker training, identified important factors contributing to effective training outcomes (Robson et al., 2010). These include changes in worker knowledge, beliefs, attitudes, skills, motivation and behavioral intentions. They also divided outcomes into

immediate reactions and intermediate outcomes where transfer of knowledge into practice is noted. When evaluating SAVE we attempted to capture changes in workers’ knowledge, beliefs and attitudes, immediately following training and at three and six months after training, to capture more intermediate outcomes, such as workers adopting new work practices.

Safety voice use, safety participation, and safety compliance (Tucker et al., 2008) (DeArmond et al., 2011) were measured with a series of questions employing a 100 mm visual analog scale. Participants expressed percentage of the time they engaged in behaviors or took actions that affected safety conditions at work, with a scale that was anchored by “never” at 0%, and “always” at 100%. The measures used in this study were adapted from existing inventories (Tucker et al., 2008) (DeArmond et al., 2011). Three subscale scores were developed by averaging responses measured in millimeters across questions within a construct: Safety Voice Use, Safety Participation, and Safety Compliance.

Adoption of ergonomic practices was evaluated by participants with questions about ergonomic practices and safety voice use for work practices such as adjusting scaffolding, using lightweight block or H block, or working in lift teams. Our analyses focused on three questions about ergonomic practices to determine if responses changed over time. Participants responded on a 5-point Likert scale anchored by “always” and “never.”

Knowledge acquisition was evaluated by having participants complete a 16-item multiple-choice knowledge test to assess knowledge about ergonomic and safety voice principles covered in the SAVE program. Item analyses determined individual items to have sound measurement properties: items averaged a point-biserial discrimination index of 0.40, and an average item difficulty of 59%. Separate subscale scores were developed for ergonomics items and safety voice items.

Apprentices’ reaction to SAVE Training in the E and ESV groups was measured at the conclusion of participation (6-month assessment) with six 5-point scale questions (strongly disagree to strongly agree).

2.5. Data analyses

Using a randomized control trial (RCT) study design, data analyses assessed the central hypothesis that the combination of ergonomics and safety voice training would be more effective (as reflected in each outcome) than no training or ergonomics training alone. We initially assessed whether demographic characteristics and baseline outcome scores were comparable between study arms with univariate analyses of variance for continuous variables, and chi-square tests for categorical variables. For continuous study outcomes, preliminary analyses included inspection of descriptive statistics and features of the data to determine need for data transformations for non-normal data; no transformations were necessary.

Linear mixed modeling (LMM) was employed to model the effect of training group (E, ESV, or C), time of measurement (baseline, 2-weeks, 3-months, 6-months), and the interaction between training group and measurement time as fixed effects with baseline scores employed as a fixed covariate for the continuous outcome measures: MNQ total body regions with pain, work prevention, and healthcare utilization; safety voice use, safety participation, safety compliance, safety voice, and ergonomic knowledge scores. Covariance structure of the repeated measures residuals for time of measurement was modeled as a first order autoregressive matrix with homogeneous variances. The analyses modeled separate intercepts and slopes for individual training centers and participants nested within training centers as random effects, with covariance structure modeled as a scaled identity. Model estimates were obtained using restricted maximum likelihood estimation. Wald statistics were reviewed to evaluate the need for including random intercepts and slopes in models. LMM allowed us to account for dependence in repeated measures and accommodate correlated errors, unequal correlations among time points, and unbalanced data resulting from missing

Table 1

Demographic characteristics per group. Asterisks denote variables for which percentages differed significantly between groups ($P < .05$). Percentages within a variable may not sum to 100% due to rounding. Total $n = 127$.

Variable		Ergonomics Only (n = 48)	Ergonomics + Safety Voice (n = 52)	Control (n = 27)
Sex	Male	100%	94%	96%
	Female	0%	6%	4%
Race/Ethnicity	African American/Black	12%	27%	8%
	American Indian/Alaska Native	2%	0%	0%
	Asian	0%	0%	8%
	Latino or Hispanic	17%	16%	8%
	White or Caucasian	68%	52%	62%
	Other or Multi-racial*	0%	6%	15%
Education Completed	Some High School or Less	2%	4%	0%
	High School Graduate	48%	50%	59%
	Trade/Technical School Training	15%	21%	4%
	Some College/Associate Degree	27%	19%	15%
	College Graduate	8%	6%	22%
Masonry Work Performed Most Often	Brick and Block	94%	78%	93%
	Other	6%	22%	7%
Setting Where Masonry Work Mainly Performed	Residential	4%	4%	7%
	Commercial	83%	90%	89%
	Industrial	13%	6%	4%
Mean SF-12 Component Scores (SD)	Physical Component Summary	53.7 (5.6)	53.9 (6.1)	52.5 (7.2)
	Mental Component Summary	49.9 (11.0)	50.7 (10.2)	47.5 (11.3)
Previous OSHA10 Training*		78%	56%	93%
Previous OSHA30 Training*		27%	52%	15%
Previous Ergonomic Training		19%	16%	15%
Previous Stretch & Flex Training		39%	28%	31%
Mean Age (SD)		28 (7.0)	29 (8.3)	31 (6.2)

data points.

Chi-square analyses compared responses among groups for the following outcomes measured on nominal scales: adoption of ergonomic practices questions, and apprentice reaction to SAVE training items. Statistical analyses were performed with SPSS version 23.0 (SPSS, Chicago, IL) using a type I error rate of $P < .05$.

3. Results

3.1. Demographic characteristics

Demographic characteristics, masonry experience/education, and general physical and mental health for the sample are provided in Table 1. Groups did not differ significantly on age or general physical or mental health (SF-12 PCS and MCS scores). Groups differed significantly on the variables race/ethnicity, previous OSHA 10 training, and previous OSHA 30 training (P s = .018, .001, and 0.003, respectively). Follow-up Z-tests with Bonferroni correction indicated a significantly larger proportion of other or multiracial participants in the C group than the E group, a significantly larger proportion of participants in the C group than the ESV group with previous OSHA 10 training, and a significantly larger proportion of participants in the ESV group than the C group with previous OSHA 30 training (all $P < .05$). In all, nearly 100% of all groups had either OSHA 10 or OSHA 30 training.

3.2. Outcome measures

Details of musculoskeletal symptom findings are published elsewhere (Anton et al., 2020). No significant differences were detected in musculoskeletal symptoms among groups or group by time interactions for the total number of body regions for which apprentices endorsed pain, work prevention, or healthcare utilization (all $P > .180$). Even though they are early in their career, participants in all groups reported a high number of musculoskeletal symptoms, especially in the lower back and wrist/hands.

For safety voice use, safety participation, and safety compliance the LMM of safety voice use revealed a significant main effect for group ($P = .049$) and a significant group by time interaction ($P = .003$). LMM of

safety participation indicated a significant main effect for group ($P = .028$) but no group by time interaction. Pairwise contrasts with Bonferroni adjustment indicated that the ESV group differed significantly from the C group at $P < .05$ on both measures. No other pairwise comparisons were significant. Simple effects testing of means in the safety voice use interaction revealed significantly larger scores for the ESV group than the C group at 2-weeks and 6-months. LMM did not reveal a group main effect or interaction for safety compliance. Estimated means (after covariate adjustment) for group main effects are in Table 2.

Evaluation of adoption of ergonomic practices using Chi-square testing, did not reveal differences among groups at baseline for frequency of thinking about good body postures at work ($P = .834$). However, at 2-weeks and at 3-months post-training, groups differed significantly ($P = .036$ and $.042$, respectively). Proportions per group (Fig. 2a, b, c) indicated that a majority of E and ESV participants endorsed “most of the time” or “always,” while C group participants most frequently endorsed “sometimes.” Differences among groups were not significant at 6-months ($P = .066$), although the trends in responses were similar to differences among groups at the other time points.

For the frequency of speaking up when other workers do not use good ergonomic solutions, chi-square testing revealed no differences among groups at baseline ($P = .691$). However, at 3-months, and 6-months, groups differed significantly ($P = .005$ and $.006$, respectively). Proportions displayed in Fig. 2b indicated that a majority of E and ESV participants endorsed “always,” “most of the time,” or “sometimes,” while C group participants most frequently endorsed “rarely” or “never.” Differences among groups were not significant at 2-weeks ($P = .051$), although the trends in responses were similar to that for the other time points.

Evaluation of the frequency of adjusting scaffolding to keep work between knees and shoulders, using chi-square testing, revealed no differences among groups at baseline ($P = .328$). However, at 2-weeks groups differed significantly ($P = .016$). Proportions displayed in Fig. 2c indicated that a majority of E and ESV participants endorsed “always” or “most of the time,” while C group participants most frequently endorsed “sometimes.” Differences among groups were not significant at 3-months or 6-months ($P = .095$ and $.080$, respectively),

Table 2

Items completed by all groups to assess change in safety voice use, safety participation, and safety compliance. Participants responded on a 100 mm visual analog scale anchored by “Never” at 0%, and “Always” at 100% to express percent of the time they engaged in behaviors or took actions that affected safety conditions at work. Estimated means (SD) in mm per aggregated scale are reported for each group.

	Ergonomics	Ergonomics + Safety Voice	Control
Safety Voice Use Items*	57.3 (22.7)	65.1 (21.5)	52.4 (23.3)
Speak to co-workers at risk and encourage them to fix safety problems			
Tell my supervisor about the consequences of dangerous working conditions			
Group together with co-workers and take safety concerns to the supervisor			
Tell my supervisor about hazardous work			
Talk to the owner about safety concerns			
Remind co-workers to take precautions			
Safety Participation Items*	55.8 (21.7)	62.1 (19.4)	48.2 (22.8)
Explain to other workers that you will report safety violations			
Try to change the way the job is done to make it safer			
Speak up and encourage others to get involved in safety issues			
Take action to stop safety violations in order to protect the well-being of other crew members			
Attend non-mandatory safety orientated training			
Safety Compliance Items	75.2 (17.9)	73.2 (16.3)	71.4 (19.1)
Apply work practices to reduce exposures to hazards including standard operating procedures relating to operations & construction			
Use appropriate personal protective equipment as indicated by the site health and safety plan			
Take the appropriate steps if prevented from or punished for exercising your rights under OSHA policies and procedures			
Appropriately report injuries, accidents, or illnesses			
Assist others to make sure they perform their work safely			

*Ergonomics + Safety Voice group differed from C group at $P < .05$.

although the trends in responses were similar to that for the 2-week time point.

No significant differences for knowledge acquisition were detected among groups or group by time interactions for mean percent correct scores on ergonomics knowledge items or safety voice knowledge items (all $P > .178$).

Chi-square tests of responses to items assessing apprentice reaction to SAVE training indicated no significant differences among responses from E and ESV groups (all $P > .176$); therefore, aggregated percentages per item are in presented (Table 3). The majority of apprentices receiving training agreed or strongly agreed that the SAVE program was enjoyable and useful, prompted change in behavior, and felt the refresher text messages reinforced content. The majority would endorse the program to co-workers.

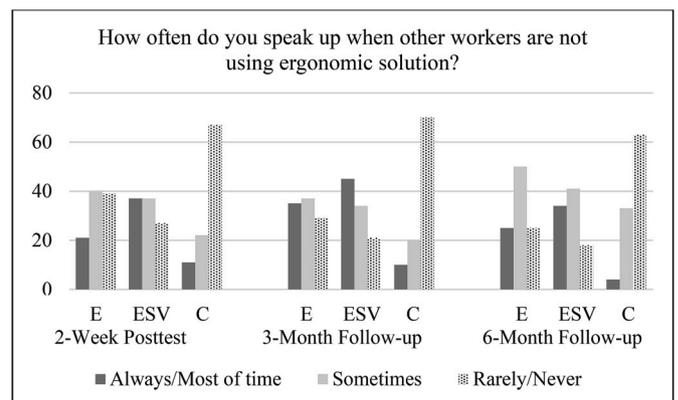
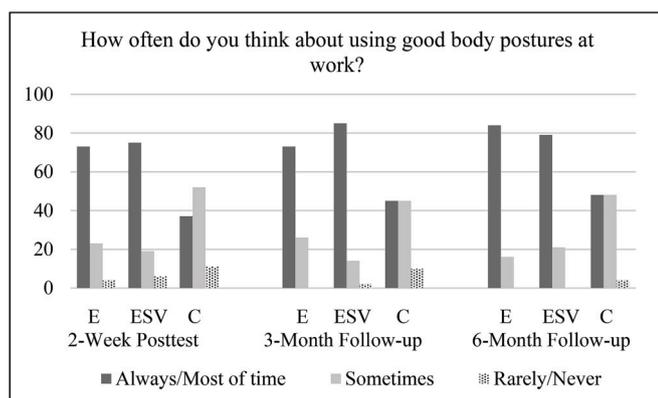


Fig. 2b.



*E= Ergonomics; ESV = Ergonomics and Safety Voice; C = Control Group

Fig. 2a. Percentage of respondents in each category to questions on ergonomic practices at 2-weeks (n = 127), 3-months (n = 102), and 6-months (n = 93). Percentages within a group may not add to 100% due to rounding. *E = Ergonomics; ESV = Ergonomics and Safety Voice; C = Control Group.

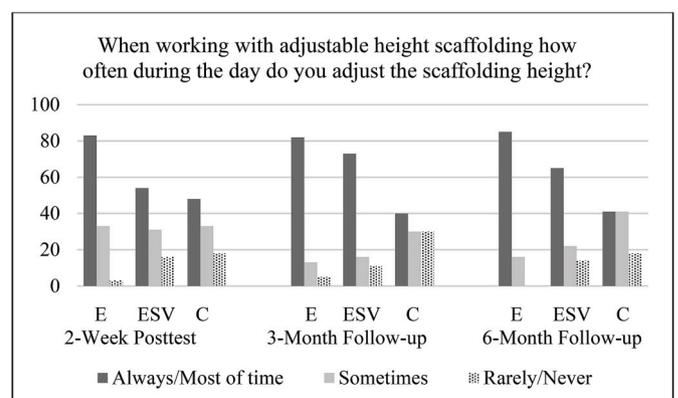


Fig. 2c.

Table 3

Items completed by participants in the Ergonomics and Ergonomics plus Safety Voice groups at the conclusion of participation (6-month follow-up) to assess reaction to SAVE training. Groups did not differ significantly on any item; therefore, percentages are aggregated across groups. Percentages within an item may not add to 100% due to rounding.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I really enjoyed participating in the program.	48%	40%	10%	0%	2%
The program was extremely useful for improving my health and safety.	42%	36%	17%	3%	2%
I changed behaviors as a result of participating in the program.	42%	42%	10%	3%	3%
Information provided in the program was excellent.	37%	49%	12%	0%	2%
I would recommend this program to my co-workers.	42%	45%	9%	3%	2%
The text messages I received from the SAVE team really helped to reinforce the program.	36%	33%	22%	5%	5%

4. Discussion

The SAVE Program integrates ergonomic principles with trade specific solutions, safety communication, and problem solving skills. Our objective was to enhance masonry apprentices' ability to actively engage in the process of identifying hazards and to problem solve solutions with viable strategies. SAVE primary training was integrated into ongoing apprenticeship training, and reinforced by text messages for 6-months following the training. Our results indicate that SAVE was well-liked, it increased the frequency that apprentices' spoke up about hazards, and facilitated their use of proven solutions to ergonomic hazards at work.

Musculoskeletal Symptoms reported by participants did not change over the six-month study period and there were no differences among groups. At the onset of the SAVE study all three groups reported having high rates musculoskeletal pain, especially in the low back and hands and wrists. Non-specific low back pain likely results from work-related repetitive stooping combined with frequent heavy lifting. The associations between specific MSDs and job tasks have been well established among workers in general and construction workers, specifically (Kilbom et al., 1996) (Holmström et al., 1995). For example, shoulder and back injuries in construction workers are associated with frequently working above shoulder level or below the knees. Wrist and hand symptoms are also common in apprentices as they develop forearm and hand muscles while learning troweling, as well as from repetitively lifting brick and block (Boschman et al., 2012) (Cook et al., 1996). Our research team was not surprised at the lack of change in musculoskeletal symptoms since the goal of SAVE was to prevent cumulative trauma injuries, not treat them. Cumulative trauma may progress slowly, over months or years, so changes in symptoms after six months would be unlikely. That said, our data did verify that apprentices' symptoms did not worsen over six months to a level of discomfort that resulted in greater time loss or the need for medical care.

Our findings demonstrated that apprentices who received the SAVE Program were assimilating the material and applying it on the job. In practical terms, their responses to survey questions indicated that they engaged in safety practices beyond talking among themselves about safety hazards, such as by reporting safety violations and attending non-mandatory safety meetings, to make their job safer. This is significant because in construction, worker involvement in safety, in addition to management commitment to safety, has been shown to be an important component of safety climate (Dedobbeleer and Béland, 1991). Yet, there are a number of reasons why workers do not report safety hazards. Studies have reported that health care workers don't speak up because they feel their input is ignored (Okuyama et al., 2014) (Pronovost, 2010). Workers may also be fearful of the consequences of reporting hazards, such as the fear that what they say could be held against them or because they believe it might be seen as challenging authority (Gephart, 2009). Young workers may take a 'wait and see' approach because of fear of being fired and feelings of powerlessness (Tucker and Turner, 2013). Masonry instructors conveyed to our research team that the construction industry has historically promoted a hierarchical culture where apprentices know that their place is to keep quiet and do as

they are told. Yet, after taking the SAVE training masonry apprentices were more willing to speak up and get involved in workplace safety. Still, these soft skills are a fairly new concept in construction and they are not yet a common component of apprenticeship or leadership training programs. Further development and refining of the soft skills training aspect of SAVE would likely result in even greater adoption of safety voice practices. Journey level masons and supervisors should also take SAVE training to ensure that apprentices are heard and that safety communication is promoted at all levels.

Apprentices who received E or ESV training demonstrated greater adoption of safe work practices such as using better body postures, speaking up when co-workers did not use ergonomic solutions, and adjusting scaffolding to keep the work between their knees and shoulders. While there was a trend toward applying SAVE ergonomic and safety voice principles and practices at all evaluation periods (2-weeks, 3-months and 6-months), only 'speaking up when others weren't using ergonomic solutions' was significant at 6-months. Since apprentices worked on jobsites where other workers and supervisors had not received SAVE training, this lack of support may have diminished their confidence over time about speaking out or attempting to initiate more substantive changes.

Our team was surprised there weren't greater differences in ergonomic and safety voice knowledge questions over time among the ESV, E and C groups. Based on responses to knowledge questions during pilot testing, our questions were robust and should have demonstrated differences over time. However, following piloting, our team did revise the knowledge acquisition questionnaire, removing or amending several questions that appeared to be confusing during pilot testing. We speculate that the final survey questions used in the assessment were too easy for this group, all of whom had taken either OSHA 10 or OSHA 30 training. While not specifically ergonomics, OSHA training does discuss jobsite hazards. This could have provided a greater basis for the types of knowledge questions asked than we anticipated. Further, 15%–19% of participants indicated they had prior ergonomics training. Even though apprentices did not demonstrate significant improvement in knowledge on pre-post training questionnaires, reported changes in safety voice use and application of ergonomic principles and practices on the job three and six-months following the training suggest that apprentices were integrating SAVE concepts into their work behavior. This comports with NIOSH's definition of a positive intermediate outcome, representing the transfer for knowledge into practice over time (Robson et al., 2010).

Apprentices who participated in SAVE, compared to controls, indicated that they enjoyed SAVE, would recommend it to co-workers, and found it useful for prompting themselves to change their safety behavior. These are important findings, since without acceptance, SAVE principles and practices would likely be dismissed by workers. Millennials (born after 1980) currently make up over 35% of the US labor force, making them the largest generation in the labor force (Bialik and Fry, 2019) (Ng, 2010), and by 2025 they are expected to make up 75% of the workforce (Winograd and Hais, 2014). While there are many characterizations of millennials, literature frequently suggests that younger workers want to have an impact on their organization, fewer boundaries, the ability to speak up more freely, and are looking for work that is meaningful and

fulfilling (Weber, 2017) (Winograd and Hais, 2014) (Ng, 2010). SAVE training offers millennial workers knowledge and skills to be more vocal and engaged in the masonry organization as safety leaders, contributing to a safer work environment for all workers, and contributing to a more fulfilling career.

These positive SAVE training safety voice and ergonomic practice findings underscore the need for broader, more sustainable programs that engage others on job sites including journey level workers, supervisors, workers in other trades, safety officers, and contractors. Engaging supervisors is particularly important. Research shows that rates of future work-related injuries are higher when levels of safety voice are high, but supervisor openness to safety voice is low (Tucker and Turner, 2014). Moreover, supervisor interaction with workers on safety issues enhances workers' safety behavior and safety climate perceptions (Zohar and Luria, 2003). Therefore, adoption of SAVE principles and practices by apprentices could be enhanced by combining the SAVE Program with other established safety climate and leadership programs for supervisors, such as CPWR's Foundations for Safety Leadership (FSL) or Building Safety for Everyone (Goldenhar et al., 2019) (Sparer et al., 2016). FSL is a 2.5-hour construction-specific leadership training that can be taught as an OSHA elective. The Building Safety for Everyone program consists of weekly feedback and communication using posters on safety performance, visible safety reports, and recognition when meeting safety goals. Coupling the knowledge and communication skills apprentices gain from SAVE with supervisor programs that promote and sustain worker involvement would promote a more cohesive and comprehensive safety culture where speaking out to resolve hazards is the norm rather than the exception.

4.1. Strengths and limitations

The major strengths of this clinical trial included the use of a clustered RCT in an actual construction practice setting for our interactive, blended learning methods; engagement of IMI masonry instructors and ongoing feedback from our partnership with masonry stakeholders (Masonry r2p Partnership) throughout the SAVE project. Additionally, we employed a wide range of outcome assessments to detect multi-dimensional change as a result of the intervention, across the domains of knowledge, attitude, and behavior. These strengths provided a solid foundation for developing and testing an implementable training program in a real-world setting. The SAVE Program focused on apprentices, who are younger, more vulnerable workers in need of tools to be proactive at work, to prevent MSDs. They are also the next generation of workers. As such, they have not been hardened into poor work habits and are in an excellent position to absorb new ideas and promote changes in safety culture.

Limitations of this study include potential threats to validity due to loss to follow-up. This was minimized in all groups by using robust follow-up methods to ensure that participants returned questionnaires. Additionally, it is possible that control participants (and their instructors), upon finding that assignment was not to an intervention arm, might have suffered from such uncontrolled threats to internal validity as contamination, diffusion of treatment, attrition, or a John Henry effect. We have no evidence that attrition differentially affected the control group more than the intervention groups. Diffusion of treatment and contamination were mitigated through the use of a clustered design with study groups geographically distant from one another. While a John Henry effect could have been at play, measuring outcomes at multiple time points across a 6-month period allowed for potential reactive arrangements to subside over time.

5. Conclusions

Our research team developed and rigorously evaluated the SAVE training. We accomplished our objective of improving apprentices' ability to engage in promoting safety on their work sites by applying

ergonomic solutions and speaking up when they noticed hazards. The seven-unit SAVE training is an evidence-based training that moves beyond traditional generic ergonomic trainings, to provide an interactive experience, with trade specific, effective solutions, and practice applying safety communication and problem solving skills. SAVE was well received by instructors and apprentices and those who received SAVE training enhanced their participation and use of safety voice and ergonomic principles on jobsites. SAVE training has been broadly disseminated with over one hundred IMI instructors, representing 60 apprenticeship training centers across the US, trained and teaching SAVE to apprentices.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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