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Effectiveness of Text Message Ergonomics Refresher Training in Young Masonry Apprentices

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Abstract: Work-related musculoskeletal disorders (MSDs) are common among brick and block masons (masons). Ergonomic solutions are essential to reduce risk factors associated with MSDs, and should be promoted during masonry apprenticeship training. **SA**fety **V**oice for **E**rgonomics (SAVE) is a program that integrates ergonomic training and safety problem-solving skills ("safety voice") into masonry apprenticeship training. Apprentices received 3-4 hours of ergonomics and safety voice training with their standard masonry instruction. To reinforce primary SAVE training, secondary training was implemented by sending weekly knowledge refresher text messages (short-message service, SMS) after primary training was complete. While previous investigators have used SMS for health reminders, little is known about the effectiveness of texting for reinforcing safety and health knowledge retention or if apprentices will be responsive to texting. The purpose of this study was to evaluate response to secondary SMS refresher training among masonry apprentices in the SAVE program. Methods: SAVE effectiveness is currently being evaluated in a randomized controlled trial at masonry apprenticeship training centers across the US. Apprenticeship centers were randomized to ergonomics training only, ergonomics and safety voice training, or a control condition. Instructors provided primary training at the center and apprentices received SMS over a six-month period. Text messages reinforced knowledge, tested knowledge, or assessed behavior. Effectiveness of SMS reminders was measured by response rate, accuracy rate to quiz questions, or behavior rate. Results: Apprentices from six centers (n = 55) have received a total of 394 SMS requiring a response for up to 3 months. The mean response rate was 54%, accuracy rate of correct responses was 82%, and behavior rate was 58%. Discussion: The high response rate suggests that SMS may effectively provide secondary ergonomics and safety voice refresher trainer. Training knowledge appears to be maintained over a two-month period.

Keywords: musculoskeletal, SMS, smartphone, texting

1. Introduction

Work-related musculoskeletal disorders (MSDs) continue to plague the construction industry. Brick and block masons (masons) are among the most affected of all construction workers (Entzel, Albers, Welch, 2007). Masons have the highest rate of overexertion injuries among all construction trades and rank second for back injuries (CPWR, 2013). Ergonomic solutions are the primary method of reducing exposure to risk factors associated with MSDs. However, many construction workers, beginning with trade apprentices, lack knowledge about ergonomic principles, solutions, and associated risk factors for MSDs. In addition, apprentices may not have training on how to appropriately respond to unsafe work environments and practices. These soft skills include self-control strategies, communication methods, and conflict resolution approaches to help them develop a "safety voice" about safety in general, and ergonomics specifically.

Construction industry trainees, such as masonry apprentices, are an important population to target with ergonomics training to promote safe work habits early in their trade. **SA**fety **V**oice for **E**rgonomics (SAVE) integrates ergonomic training and safety voice principles into masonry apprenticeship training. In addition to traditional apprenticeship instruction, apprentices receive 3-4 hours of ergonomics and safety voice training, also called "primary training." In order to reinforce knowledge and skills gained from primary training, "secondary training" in the form of text messaging or short-message service (SMS) was used to reinforce knowledge gained from primary training, leveraging the near ubiquitous use of smartphones as a communication tool.

Several theories support the use of SMS for short-term behavioral change (Orr & King, 2015). In addition, text messaging has been increasingly studied as a method for health promotion. A recent review reported that SMS interventions were successful in promoting behaviors such as smoking cessation, increased physical activity, weight loss, and safer sex (Head, Noar, Iannarino, & Grant Harrington, 2013). Several studies have also indicated that SMS reminders effectively improve medication adherence (Fenerty, West, Davis, Kaplan, & Feldman, 2012; Park, Howie-Esquivel, & Dracup, 2014). Additionally, using SMS to administer health questionnaires has been shown to be as effective as paper or computer-administered questionnaires (Christie, Dagfinrud, Dale, Schulz, & Hagen, 2014). A review by Kannisto et al. (2014) reported that SMS improved outcomes in 77% of included studies. Text messaging has improved outcomes for some constructs such as improving medication adherence and appointment attendance, but not others, such as oral contraceptive use. Vodopivec-Jamsek et al. concluded that there is high quality evidence supporting the use of SMS for smoking cessation, but suggested that, overall, limited evidence exists to support SMS as an educational delivery medium (Vodopivec-Jamsek, de Jongh, Gurol-Urganci, Atun, & Car, 2012).

Few occupational health studies have used SMS to influence safe behavior (Duffy, Ronis, Waltje, & Choi, 2013) and few studies have used SMS for assessing knowledge (de Lepper et al., 2013; Froisland, Arsand, & Skarderud, 2012). Specific to the masonry trade, it is unknown if apprentices would be responsive to SMS reminders to reinforce occupational health and safety knowledge. The purpose of this study was to evaluate masonry apprentice responses to the use of SMS for refresher training and knowledge retention. An additional purpose was to estimate ergonomics and safety voice behavioral change through the use of SMS.

2. Methods

2.1 SAVE Study Design

The SAVE Program is currently being evaluated in a three group, cluster randomized-controlled study. Approximately 96 masonry apprentices are being recruited to participate from 12 training centers throughout the US. Clusters of apprentices within centers are randomly assigned to one of three training intervention groups: 1) ergonomics training alone, 2) ergonomics and safety voice training, or 3) control group with no additional training intervention (primary or secondary). The apprenticeship training instructor provided the training after receiving materials and train-the-trainer instruction from a research team member.

Outcomes of SAVE include ergonomics and safety voice knowledge, and ergonomic solution attitude and adoption, as well as responses to two health questionnaires. Questionnaires were mailed to apprentices on three occasions after baseline assessment: two weeks post primary training (for the control group, this occurs two weeks following baseline assessment), at 3 months, and at 6 months. Participants received a monetary incentive for returning a questionnaire.

Starting after the two-week assessment, apprentices in the ergonomics only group and ergonomics plus safety voice group received messages. In all, 40 SMS covered content from primary training ergonomics units, while 28 SMS covered content from the primary training safety voice units. The 40 ergonomics messages are sent over a 6-month period to

participants in the ergonomics only study arm, while all 68 SMS are sent over a 6-month period to participants in the ergonomics plus safety voice study arm. Half of the messages contain a question to which apprentices must reply with a yes/no or other brief response, while the other half require no response, and simply repeat concepts covered in primary training. The overall design for assessing the effectiveness of primary and secondary SAVE training is a 2 x 2 x 4, Ergonomic Training (yes/no) by Safety Voice Training (yes/no) by Time of Measurement factorial design with repeated measures on the last factor and apprentices nested within training centers. The currently reported data is from a sub-study testing the effectiveness of the SMS intervention as refresher training. SAVE has been approved by the Institutional Review Board (IRB) of Eastern Washington University, the IRB of record for this project.

2.2 SMS Sub-Study Design

Text messages were sent to 55 apprentices at six training centers to date. Messages were sent using an automated SMS distribution system (slicktext.com) that allowed for SMS to be sent at pre-determined intervals. All SMS were sent at 10:00 am (local time) on the scheduled dates. Messages sent to apprentices alternated between SMS to reinforce/refresh knowledge learned during primary training, quiz questions testing knowledge retention, and questions that assessed behavioral changes.

An example of a *knowledge reinforcement* SMS was, “Remember to shift to neutral,” intended to remind apprentices to limit awkward postures of the low back. A *quiz question* SMS example was, “Does the A in HARP stand for Awkward Postures?” The apprentice responded “Yes” or “No.” Finally, an example of a *behavioral change assessment* SMS was, “During the past week have you worked on adjustable scaffolding?” As with the quiz questions, the apprentice responded “Yes” or “No,” and then received a follow-up reinforcement SMS. In this case, apprentices were reminded to keep work in the safe zone between shoulders and knees. Safety voice SMS were also sent, such as, “During the past week, did you speak up to a coworker or supervisor about something you saw that was unsafe?” Regardless of response, a follow-up SMS would state, “Speaking up if you see an unsafe work situation can keep you and your coworkers from getting injured.” Text message data was downloaded from the SMS system and analyzed by each training center.

Text messages were sent 3-5 times a week depending on study group for the first several weeks after primary training. The frequency of SMS was then reduced to 2-3 times weekly by the fourth week, and then 1-2 times per week by 3 months.

2.3 SMS Data Analysis

Descriptive statistics were used to calculate means and percentages for the demographic data. Text messaging *response rate* was calculated by the number of SMS responses received from apprentices divided by the total of SMS sent to apprentices. Messages received by apprentices were further divided into those assessing knowledge (i.e., quiz questions) and those assessing behavior. *Accuracy rate* was defined as correct responses to quiz questions divided by SMS received. *Behavior rate* was defined as SMS requiring a response assessing behavior divided by SMS sent. Analyses of frequency counts and subsequent statistics were doubly verified with manual counts.

3. Results

Demographics of the 55 apprentices are in Table 1. All participants were male. Most participants were Caucasian with the race distribution consistent with the locations of training centers. Most apprentices were in their first two years of apprenticeship training. Consistent with many trades, most participants entered their masonry apprenticeship after graduating from high school. Since apprenticeship training programs may be associated with a community college, some participants had an associates degree or some college education.

To date, a total of 394 SMS requiring a response have been sent to 55 participant apprentices from six centers. The mean response rate was 54% among all centers. In general, the participants responded correctly to the quiz question SMS with an accuracy rate of 82%. Behavioral rate was estimated as 59%.

Table 1. Participant Demographics Per Intervention Group for SMS Sub-Study

Group	Ergonomics (n=38)	Ergonomics & Safety Voice (n=17)
Mean Age (SD)	26.1 (5.9)	24.4 (6.1)
Race (%)		
African American	10.5	11.8
American Indian	2.6	0
Latino or Hispanic	15.8	5.9
White/Caucasian	71.1	82.4
Apprenticeship Year (%)		
1	76.3	17.6
2	10.5	64.7
3	10.5	5.9
4	2.6	11.8
Highest Education Level (%)		
High School Graduate	39.5	70.6
Trade or Technical School	13.2	11.8
Associate Degree or Some College	26.3	11.8
College Graduate	10.5	5.9
Other	10.5	0

Table 2. Text-messaging (SMS) Descriptive Statistics

	All participants (n=55)
SMS Requiring Responses	394
Response Rate (%)	54
SMS Measuring Knowledge Retention	250
Accuracy Rate (%)	82
SMS Measuring Behavioral Change	144
Behavioral Rate (%)	59

4. Discussion and Conclusion

The response rate of 54% indicates that masonry apprentices are responsive to SMS reminders. Others researchers have reported response rates ranging 22-100% (Kannisto et al., 2014) and have concluded that SMS is effective in promoting high response rates (Christie et al., 2014; Park et al., 2014; Richmond et al., 2015). Although few occupational health studies have used SMS, Burstrom et al. (2016) reported a mean response rate of 93% when using SMS to determine incidence of low back pain among mining workers. The investigators considered SMS such an efficient vehicle for assessing pain that they considered 80% a "very low response rate."

Knowledge retention appeared to be high with 82% of apprentices answering quiz questions correctly. Before starting the randomized controlled trial, quiz questions were piloted at three training centers to assure a balance of difficult and easy questions. It would seem that allowing simple SMS answers (i.e., "yes" or "no") may provide a better response rate.

The current study results suggest that SMS may successfully and efficiently reinforce ergonomic concepts. Targeted, customized SMS seem more effective than generic messages (Head et al., 2013). Therefore, the majority of SMS created for SAVE emphasized masonry tasks and postures rather than general ergonomic principles. Future use of SMS in SAVE may benefit from messages tailored to individual apprentice response, since combined targeted and tailored SMS have even greater effectiveness (Head et al., 2013).

Adoption of healthy behavior is the ultimate result of occupational health training (Robson et al., 2010), such as apprentice masons maintaining scaffold height to allow material handling between knee and shoulder height. However, we are unable to confirm whether behavior actually changes. As a proxy measure for behavior, we asked participants SMS questions such as, "During the past week have you worked on adjustable scaffolding?" There are obvious limitations of

proxy measures such as this and observation of the apprentices at the worksite, if possible, would indicate if behaviour actually changed.

Message frequency also has an effect on health intervention effectiveness (Head et al., 2013). Repeated SMS that state the same text are less effective than intermittent SMS. In contrast, message frequencies that are too low may be ineffective (Orr & King, 2015). Hawkins et al. (2010) suggested that the individual receiving the SMS must sense the "social presence" of the sender for effective intervention. In SAVE, we used a gradual reduction in SMS as project time progressed.

An additional use of SMS in SAVE is to remind participants to complete mailed questionnaires. Keding et al. (2016) reported that SMS is not effective for improving questionnaire compliance. In the current study, SMS appears to motivate some participants to return their questionnaires. In SAVE, study apprentices are additionally contacted by phone when non-responsive to SMS. In conclusion, the response rate in this study suggests that texting may effectively provide secondary ergonomics and safety voice refresher trainer. Training knowledge appears to be maintained over a two-month period.

5. References

Burstrom, L., Jonsson, H., Bjor, B., Hjalmarsson, U., Nilsson, T., Reuterwall, C., & Wahlstrom, J. (2016). Daily text messages used as a method for assessing low back pain among workers. *Journal of Clinical Epidemiology, 70*, 45-51. doi:10.1016/j.jclinepi.2015.08.011

Christie, A., Dagfinrud, H., Dale, O., Schulz, T., & Hagen, K. B. (2014). Collection of patient-reported outcomes;--text messages on mobile phones provide valid scores and high response rates. *BMC Medical Research Methodology, 14*, 52. doi:10.1186/1471-2288-14-52

CPWR - The Center for Construction Research and Training. (2013). *The Construction Chart Book. 5th ed.* Silver Spring, MD: CPWR - The Center for Construction Research and Training

de Lepper, A. M., Eijkemans, M. J., van Beijma, H., Loggers, J. W., Tuijn, C. J., & Oskam, L. (2013). Response patterns to interactive SMS health education quizzes at two sites in Uganda: a cohort study. *Trop Med Int Health, 18*(4), 516-521. doi:10.1111/tmi.12059

Duffy, S. A., Ronis, D. L., Waltje, A. H., & Choi, S. H. (2013). Protocol of a randomized controlled trial of sun protection interventions for operating engineers. *BMC public health, 13*, 273. doi:10.1186/1471-2458-13-273

Entzel, P., Albers, J., Welch, L. (2007). Best practices for preventing musculoskeletal disorders in masonry: stakeholder perspectives. *Appl Ergon, 38*, 557-566

Fenerty, S. D., West, C., Davis, S. A., Kaplan, S. G., & Feldman, S. R. (2012). The effect of reminder systems on patients' adherence to treatment. *Patient Prefer Adherence, 6*, 127-135. doi:10.2147/PPA.S26314

Froisland, D. H., Arsand, E., & Skarderud, F. (2012). Improving diabetes care for young people with type 1 diabetes through visual learning on mobile phones: mixed-methods study. *J Med Internet Res, 14*(4), e111. doi:10.2196/jmir.2155

Hawkins, R. P., Han, J. Y., Pingree, S., Shaw, B. R., Baker, T. B., & Roberts, L. J. (2010). Interactivity and presence of three eHealth interventions. *Comput Human Behav, 26*(5), 1081-1088. doi:10.1016/j.chb.2010.03.011

Head, K. J., Noar, S. M., Iannarino, N. T., & Grant Harrington, N. (2013). Efficacy of text messaging-based interventions for health promotion: a meta-analysis. *Soc Sci Med, 97*, 41-48. doi:10.1016/j.socscimed.2013.08.003

Kannisto, K. A., Koivunen, M. H., & Valimaki, M. A. (2014). Use of mobile phone text message reminders in health care services: a narrative literature review. *J Med Internet Res, 16*(10), e222. doi:10.2196/jmir.3442

Keding, A., Brabyn, S., MacPherson, H., Richmond, S. J., & Torgerson, D. J. (2016). Text message reminders to improve questionnaire response rates. *Journal of Clinical Epidemiology, 79*, 90-95. doi:10.1016/j.jclinepi.2016.05.011

Orr, J. A., & King, R. J. (2015). Mobile phone SMS messages can enhance healthy behaviour: a meta-analysis of randomised controlled trials. *Health Psychol Rev, 9*(4), 397-416. doi:10.1080/17437199.2015.1022847

Park, L. G., Howie-Esquivel, J., & Dracup, K. (2014). A quantitative systematic review of the efficacy of mobile phone interventions to improve medication adherence. *J Adv Nurs, 70*(9), 1932-1953. doi:10.1111/jan.12400

Richmond, S. J., Keding, A., Hover, M., Gabe, R., Cross, B., Torgerson, D., & MacPherson, H. (2015). Feasibility, acceptability and validity of SMS text messaging for measuring change in depression during a randomised controlled trial. *BMC Psychiatry, 15*, 68. doi:10.1186/s12888-015-0456-3

Robson, L., Stephenson, C., Schulte, P., Amick, B., Chan, S., Bielecky, A., . . . Grubb, P. (2010). *A Systematic Review of the Effectiveness of Training & Education for the Protection of Workers* (DHHS (NIOSH) Publication No. 2010-127). Retrieved from Toronto, ON & Cincinnati, OH:

Vodopivec-Jamsek, V., de Jongh, T., Gurol-Urganci, I., Atun, R., & Car, J. (2012). Mobile phone messaging for preventive health care. *Cochrane Database Syst Rev, 12*, CD007457. doi:10.1002/14651858.CD007457.pub2