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Topics in Construction Safety and Health
Safety Culture and Safety Climate:
An Interdisciplinary Annotated Bibliography

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8484 Georgia Avenue
Suite 1000
Silver Spring, MD 20910

PHONE: 301.578.8500
FAX: 301.578.8572

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Safety Culture and Safety Climate: An Interdisciplinary Annotated Bibliography

Abbe, O. O., et al. (2011). "Modeling the relationship between occupational stressors, psychosocial/physical symptoms and injuries in the construction industry." *International Journal of Industrial Ergonomics* 41(2): 106-117.

Injury statistics place the construction industry as a high-risk industry, making it necessary to investigate factors that influence accidents to be able to protect workers. Research was carried out to investigate the relationship existing among occupational stressors, psychological/physical symptoms and accident/injury and work days lost outcomes as experienced by manual workers engaged in a range of industrial construction occupations. Some of the occupational stressors significantly associated with self-reported and OSHA logged injuries were training, job certainty and safety climate of the company. The OSHA logged injuries were associated with the occurrence of headaches and feelings of tenseness on the job. These results imply that non-physical stressors should be included as a potential input associated with injuries in injury risk models for construction workers. Relevance to industry: Traditional approaches to workers' safety in the construction industry have focused on the physical and biomechanical aspects of work by improving tools, equipment and task completion methods. The impact of psychosocial factors, specifically stress as experienced by construction workers, is an area of growing research, which is yielding results that suggest overall work safety on the construction site should take into account psychosocial aspects of work. © 2010 Elsevier B.V.

Al-Bayati, A. J., et al. (2017). "Reducing fatality rates of the Hispanic workforce in the U.S. Construction industry: Challenges and strategies." *Journal of Construction Engineering and Management* 143(3).

Recent government statistics have revealed a high rate of fatalities among Hispanic workers in the U.S. construction industry. This study investigates the root causes of this issue as well as the existing attempts to manage these causes effectively. Cultural barriers are one of the root causes that have not been fully explored. This detailed investigation expands into an exploration of cultural barriers and differences, variables that are directly attributable to construction site safety. A survey instrument was designed to evaluate the existence and influence of these differences at U.S. construction sites, and data were collected from construction supervisors across the United States. The results of the survey strongly suggest the existence of two differences: high power distance and collectivism cultural dimensions. Based on the survey results and feedback from construction supervisors, recommendations for best practices in workforce development that guides construction professionals and researchers are suggested. © 2016 American Society of Civil Engineers.

Albers, J. T., et al. (2014). "Residential building stakeholders' attitudes and beliefs regarding nail gun injury risks and prevention." *New Solut* 23(4): 577-605.

Pneumatic nail guns are ubiquitous at residential construction sites across the United States. These tools are noted for the traumatic injuries that can occur from their operation. Different trigger mechanisms on these tools are associated with different levels of risk. Residential building subcontractors and workers, both native-born and immigrant, were brought together in focus groups to discuss their attitudes and beliefs regarding risk factors for nail gun injury as well as barriers to the adoption of safer technology. Participants' comments are organized first by influences on traumatic injury occurrence or prevention and later by sociotechnical system category. Participants attributed influences on injury risk to personal and external causation factors in all sociotechnical system categories; however, participants more frequently described influences on injury prevention as related

to workers' behaviors, rather than to external factors. A discussion of these influences with respect to attribution theory and sociotechnical models of injury causation is presented.

Arcury, T. A., et al. (2012). "Work safety climate and safety practices among immigrant Latino residential construction workers." *Am J Ind Med* 55(8): 736-745.

Background: Latino residential construction workers experience high rates of occupational fatality and injury. Work safety climate is an especially important consideration for improving the safety of these immigrant workers. This analysis describes work safety climate among Latino residential construction workers, delineates differences in work safety climate by personal and employment characteristics, and determines associations of work safety climate with specific work safety behaviors. Methods: Data are from a cross-sectional survey of 119 Latino residential framers, roofers, and general construction workers in western North Carolina; 90 of these participants also provided longitudinal daily diary data for up to 21 days using an Interactive Voice Response (IVR) system. Measures included the Perceived Safety Climate Scale, and daily reports of five individual and five collective safety practices. Results: Work safety climate was mixed among workers, with roofers (19.9) having lower levels than framers (24.3) or general construction workers (24.3). Days reported for several individual (glove-related risks, not doing something known to be unsafe) and collective safety practices (attended daily safety meeting, not needing to use damaged equipment, not seeing coworker create an unsafe situation) were positively associated with work safety climate. Conclusions: Work safety climate predicts subsequent safety behaviors among Latino residential construction workers, with differences by trade being particularly important. Interventions are needed to improve safety training for employers as well as workers. Further research should expand the number of workers and trades involved in analyses of work safety climate. © 2012 Wiley Periodicals, Inc.

Arcury, T. A., et al. (2014). "Occupational safety beliefs among Latino residential roofing workers." *Am J Ind Med* 57(6): 718-725.

Background: This analysis describes beliefs about work safety and personal protective equipment (PPE) among Latino roofing workers, it delineates their perceptions of work environment characteristics that affect work safety and PPE use, and it describes how they experience work injuries and the consequences of these injuries. Methods: In-depth interviews were completed with 10 current and former Latino residential roofers. Interview transcripts were subjected to systematic qualitative analysis. Results: Participants' valued productivity over safety, and this had a negative influence on their safety behavior and reduced their PPE use. They understood that roofing was hazardous. They limited use of PPE when they felt it reduced productivity and when it was uncomfortable. Work environment characteristics that affected safety included company size, the physical demands of the job, lack of training, the need for work, general life stress, and distractions at work. An injury had to result in lost work time to be considered significant. Access to health care is limited by employers not providing Workers' compensation. Discussion: Future research is needed to substantiate these descriptive results and to delineate factors that are associated with safety behavior and use of PPE. Interventions, based on a lay health educator model, are needed to improve safety in this population. Safety regulations need to be evaluated and their enforcement needs to be improved. © 2013 Wiley Periodicals, Inc.

Arcury, T. A., et al. (2015). "Work safety climate, personal protection use, and injuries among Latino residential roofers." *Am J Ind Med* 58(1): 69-76.

Background: This analysis describes work safety climate, personal protective equipment (PPE) use, and injuries among Latino residential roofers, and examines the associations of work safety climate with PPE use and injuries. Methods: Eighty-nine North Carolina residential roofers completed a

3 Topics in Construction Safety and Health: Safety Culture and Safety Climate

baseline interview and daily logs about perceptions and use of PPE, occurrence of injuries in last 12 months, and work safety climate. Results: The mean work safety climate score was 26.5 (SD=5.6). In the baseline interview, participants reported that the majority of employers provided PPE and that they used it most or all of the time; daily log data indicated that PPE was used for half or fewer of hours worked. 39.9% reported any injury in the last 12 months. Work safety climate was significantly correlated with the provision and use of most types of PPE, and was inversely associated with injury. Conclusions: Supervisors promoting safety may increase the PPE use and decrease injuries. © 2014 Wiley Periodicals, Inc.

Boatman, L., et al. (2012). "Creating the Climate for Making Ergonomic Changes." CPWR Report.

The purpose of this study is to learn about attitudes toward implementing ergonomic change in California construction work in the unionized sector. Our specific goal was to assess current perceptions and attitudes among construction professionals toward overcoming barriers and obstacles and voluntarily implementing ergonomic solutions.

Boatman, L., et al. (2015). "Creating a climate for ergonomic changes in the construction industry." *Am J Ind Med* 58(8): 858-869.

Background: Ergonomic solutions that have gained acceptance in other industries are often considered not applicable to a construction work environment, even though the industry is characterized by high physical work demands. Methods: We conducted 50 key informant interviews with 23 contractor representatives and 27 union staff, plus 4 focus groups with a total of 48 workers. Results: Many workers hold the belief that WMSDs are inevitable as part of the job, and did not consistently believe that changing the nature of the work could prevent that injury or pain. The interviewees reported limited availability and accessibility of tested and effective tools that both reduce physical demand and also get the job done efficiently and effectively. Yet for each major obstacle to implementation of ergonomics in the industry identified, the construction professionals we interviewed offered a variety of solutions. Conclusions: Contractors, unions, and workers need to work together to find actions that work within the parameters of the current economic environment. *Am. J. Ind. Med.* 58:858-869, 2015. © 2015 Wiley Periodicals, Inc.

Bodner, T., et al. (2014). "Safety, health, and well-being of municipal utility and construction workers." *J Occup Environ Med* 56(7): 771-778.

OBJECTIVE: To provide a baseline description of psychosocial workplace stressors and supports along with safety, injury, health, and well-being indicators in a sample of utility and construction workers for a National Institute for Occupational Safety and Health-funded Total Worker Health intervention study. METHODS: Survey responses and health assessments were collected from a total of 349 employees in two municipal utility departments. RESULTS: Participants demonstrated poor weight control and body mass index and provided reports of frequent poor health habits, injury, and pain. Although safety climate was good, less desirable levels of psychosocial workplace stressors and supports were observed. These stressors and supports were found to relate with many of the health, injury, and pain indicators. CONCLUSIONS: These results demonstrate the need for workplace interventions to promote and protect construction worker health and the importance of the psychosocial work environment.

Brown, G. D. and J. Barab (2007). "'Cooking the books'--behavior-based safety at the San Francisco Bay Bridge." *New Solut* 17(4): 311-324.

Practitioners of Behavior-Based Safety (BBS) claim dramatic reductions in worker injuries and illnesses through modifying workers' "unsafe behaviors." This case study of a BBS program

4 Topics in Construction Safety and Health: Safety Culture and Safety Climate

implemented by KFM, a giant construction consortium rebuilding the eastern span of the San Francisco Bay Bridge in California, documents how BBS was used to suppress reporting of worker injuries and illnesses on site. The key elements of KFM's BBS "injury prevention" strategy included: 1) cash incentives to workers and supervisors who do not report injuries; 2) reprisals and threats of reprisals against those employees who do report injuries; 3) selection and use of employer friendly occupational health clinics and workers compensation insurance administrators; 4) strict limits on the activities of contract industrial hygiene consultants; and 5) a secretive management committee that decides whether reported injuries and illnesses are legitimate and recordable. KFM reported injury and illness rates 55% to 72% lower than other bridge builders in the Bay Area, but the California Division of Occupational Safety and Health (Cal/OSHA) issued Willful citations to the consortium in June 2006 for failing to record 13 worker injuries on its "OSHA Log 300," as required by law.

Caban-Martinez, A. J., et al. (2014). "Construction workers working in musculoskeletal pain and engaging in leisure-time physical activity: Findings from a mixed-methods pilot study." *Am J Ind Med* 57(7): 819-825.

Background: While exercise has been shown to be beneficial for some musculoskeletal pain conditions, construction workers who are regularly burdened with musculoskeletal pain may engage less in leisure-time physical activity (LTPA) due to pain. In a small pilot study, we investigate how musculoskeletal pain may influence participation in LTPA among construction workers. Methods: A sequential explanatory mixed-methods design was employed using a jobsite-based survey (n=43) among workers at two commercial construction sites and one focus group (n=5). Results: Over 93% of these construction workers reported engaging in LTPA and 70% reported musculoskeletal pain. Fifty-seven percent of workers who met either moderate or vigorous LTPA guidelines reported lower extremity pain (i.e., ankle, knee) compared with 21% of those who did not engage in either LTPA (P=0.04). Focus group analyses indicate that workers felt they already get significant physical activity out of their job because they are "moving all the time and not sitting behind a desk." Workers also felt they "have no choice but to work through pain and discomfort [as the worker] needs to do anything to get the job done." Conclusion: Pilot study findings suggest that construction workers not only engage in either moderate or vigorous LTPA despite musculoskeletal pain but workers in pain engage in more LTPA than construction workers without pain. *Am. J. Ind. Med.* 57:819-825, 2014. © 2014 Wiley Periodicals, Inc.

Chávez, S. and C. E. Altman (2017). "Gambling with life: Masculinity, risk, and danger in the lives of unauthorized migrant roofers." *Am J Ind Med* 60(6): 537-547.

Background: This paper examines the occupational experiences of unauthorized immigrants employed in one of the most dangerous occupations in the United States: roofing. Methods: We draw on 40 in-depth interviews with return migrants in Guanajuato, Mexico, to examine how the adoption of masculinity, dangerous working conditions, the labor market structure, and absence of legal status exacerbates injuries for unauthorized roofers. Findings: Undocumented men return to Mexico injured with chronic pain, health complications, and trauma. We find that men "do gender" that is adopt masculine beliefs, when they skirt safety practices, police each other's behaviors, withhold their emotions, experience heightened stress, and engage in poor health behaviors. It is a combination of dangerous working conditions, economic insecurity, and men seeking to fulfill their masculine roles that all combine to create unsafe working conditions and lead to injuries. © 2017 Wiley Periodicals, Inc.

Chen, Q. and R. Jin (2013). "Multilevel safety culture and climate survey for assessing new safety Program." *Journal of Construction Engineering and Management* 139(7): 805-817.

5 Topics in Construction Safety and Health: Safety Culture and Safety Climate

Construction safety culture is becoming a typical proactive safety performance measurement and strategy for safety improvement. However, there is no accepted industry wide definition for safety culture. There is also no clear distinction between safety culture and safety climate. So far, little research has investigated how safety programs can be developed to improve safety culture and climate, which in turn can be used to assess the effectiveness of these programs. This paper presents a study that examined the multilevel safety culture and climate to assess a newly launched safety program. Specifically, three different questionnaires were used to survey 71 top executives, 229 site management personnel, and 350 field workers, respectively. This study found wide acceptance of the program across all three groups, strong management accountability in enforcing safety, and a positive general safety climate among workers. The results demonstrated the program's overall effectiveness in building positive safety culture and climate despite a few identified weaknesses. Based on these findings and insightful employee feedback, this paper offers generalized recommendations to help industry practitioners develop high-quality safety programs. The presented survey instruments and analysis methods can also be used to holistically assess safety programs and related safety culture and climate. © 2013 American Society of Civil Engineers.

Chen, Q. and R. Jin (2015). "A comparison of subgroup construction workers' perceptions of a safety program." *Safety science* 74: 15-26.

Subcontractor safety performance has become increasingly important due to the extensive use of subcontracting in construction and the elevated safety risks. Ensuring subcontractor safety has also become a major challenge of general contractors (GC). While many GCs leave the safety responsibility to individual subcontractors, others take active roles in helping them improve safety performance. To advance the understanding of how an active approach taken by the GC is received by subcontractors, a comparative study was performed to investigate subgroup workers' perceptions of a safety program implemented by a U.S. GC among all the workers on its jobsites. In this study, a 5-dimension 28-item questionnaire was administered to 350 workers on the GC's jobsites. The collected information was used to examine differences in workers' perceptions between selected subgroups, i.e., the GC and its subcontractors as well as high- and low-risk building trades. This research found more positive perceptions of the safety program (i.e., the overall perception and the awareness and acceptance dimensions) among the GC's workers than those of the subcontractors but no difference in perceptions from high- and low-risk trades. This research also identified differences in workers' perceptions among other subgroups (e.g., based on age ranges and safety violation records) and drew insights from workers' feedback to open-ended survey questions. The findings will help contractors better understand and manage their diverse workforce to improve jobsite safety performance. © 2014.

Choi, B., et al. (2017). "Construction Workers' Group Norms and Personal Standards Regarding Safety Behavior: Social Identity Theory Perspective." *Journal of Management in Engineering* 33(4).

A number of researchers have proposed and demonstrated that worker behavior is one of the main factors in construction safety. Working within the parameters of worker safety awareness and behavior, many researchers have recently suggested that shared values and customs, i.e., group norms, play an important role in shaping individual workers' safety behavior. Regarding how individuals' behavior is under the influence of group norms, the social identity theory suggests that people perceive themselves as a member of a group, depersonalize the self, and base their beliefs and behavior on the norms of the group. Despite the clarity of this configuration, the extent to which construction workers' safety attitudes and behaviors are influenced by group norms, and the degree to which social identification is involved in this process, remains unclear. In particular, the transient nature of construction worker employment and multiple identities that a construction worker might hold make it difficult to understand the influence of group norms on workers' safety behavior. To

address these knowledge gaps, this paper aims to identify the (1) influence of group norms on a construction worker's personal standards regarding safety behavior, (2) current status of construction workers' social identities, and (3) impact of social identification on the influence that group norms have on construction workers' personal standards regarding safety behavior. To achieve these objectives, empirical data were collected from 82 construction workers and nine project managers from three different construction sites using behavioral economic experiments along with surveys, and the data were analyzed using quantitative methods, such as correlation analysis, regression analysis, and t-tests. The analyses demonstrate that there is a measurable difference between construction workers' personal standards and the norms desired by project managers regarding safety behavior and that construction workers' personal standards regarding safety behavior are significantly influenced by their perceived group norms. The analyses also demonstrate that construction workers identify themselves with the different groups to which they belong (e.g., workgroup, trade, union, company, project) to significantly different degrees and that the salience of social identity with a group moderates the influence that the group's norms have on personal standards regarding safety behavior in construction workers. These findings suggest a new way of thinking about safety management in construction; promoting project-wide positive norms combined with improved project identity can be an effective means of improving workers' safety behavior in construction projects. © 2017 American Society of Civil Engineers.

Choi, B., et al. (2017). "Role of Social Norms and Social Identifications in Safety Behavior of Construction Workers. I: Theoretical Model of Safety Behavior under Social Influence." *Journal of Construction Engineering and Management* 143(5).

During the last several decades, behavior-based safety (BBS) has drawn a considerable amount of attention in the construction industry. The focus of BBS is on improving construction workers' safety behavior through feedback and increased self-awareness and motivation. Among the influencing factors of safety behavior, social norm is known to be a powerful mechanism that regulates workers' safety behavior. However, it is unclear how social norms are developed and through which process social norms influence an individual worker's safety behavior in construction projects. Additionally, the temporary and contract-based nature of employment in construction projects makes understanding the influence of different social norms on workers' safety behavior in construction projects especially difficult. Given this background, this paper aims to better understand the process by which different social norms exert control over construction workers' safety behavior. To achieve this goal, empirical data were collected from 284 workers from eight construction sites in the United States, Korea, and Saudi Arabia using surveys, and the data were analyzed. The results demonstrate that workers' safety behavior is influenced by perceived management norm, perceived workgroup norm, and personal attitude, and perceived workgroup norm mediates the relationship between perceived management norm and safety behavior. In addition, it is shown that social identification with the project intensifies the relationship between perceived management norm and safety behavior and attenuates the relationship between perceived workgroup norm and safety behavior. These findings contribute to the body of knowledge on construction safety by providing an explicative model for how social norms influence workers' safety behavior, and suggest that a sociopsychological approach to promote project identity and reinforce favorable social norms in construction workers can be an effective means of improving construction safety. © 2016 American Society of Civil Engineers.

Choi, B. and S. H. Lee (2017). "Role of Social Norms and Social Identifications in Safety Behavior of Construction Workers. II: Group Analyses for the Effects of Cultural Backgrounds and Organizational Structures on Social Influence Process." *Journal of Construction Engineering and Management* 143(5).

7 Topics in Construction Safety and Health: Safety Culture and Safety Climate

The roles of perceived management norm, perceived workgroup norm, and project identity in construction workers' safety behavior were described in the companion paper. That paper found that workers who strongly identify with their project demonstrate a stronger association between strict perceived management norms and safety behavior and a diminished association between lenient perceived workgroup norms and safety behavior. However, it is still unclear whether the findings are stable across different cultural backgrounds and organizational structures. To address this issue, this study aims to compare the roles of perceived management norm, perceived workgroup norm, and project identity in workers' safety behavior in different cultural backgrounds and organizational structures. The surveys were conducted in the United States, Korea, and Saudi Arabia for the group analyses because the three countries are both different from and similar to each other in terms of cultural backgrounds and organizational structure. The result demonstrated a significant relationship between social norms (e.g., perceived management norms and perceived workgroup norms) and safety behavior, but cultural and organizational contexts can make a difference in the social influence processes. It was found that workers' social identification with their projects functions as an important mechanism that moderates the relationship between social norms and safety behavior in the United States and Korea. Just as the individualistic culture in the United States leads to significant direct effects of attitudes on safety behavior, the collectivistic culture in Korea brings about the significant effects of the perceived management norm and perceived workgroup norm on safety behavior. On the other hand, in Saudi Arabia, although workers already have a salient project identity due to its system of direct hiring, interactions between project identity and social norms do not have significant associations with safety behavior because perceived management norms may not be strict enough to elicit behavioral changes in improving safety behavior. The findings from this study lay a theoretical foundation for a new approach to safety management in international construction projects. Beyond the sociopsychological aspect of safety behavior, considerations of cultural and organization context would be essential to strengthen positive social influence on workers' safety behavior in international construction projects. © 2016 American Society of Civil Engineers.

Cigularov, K. P., et al. (2013). "Measurement equivalence and mean comparisons of a safety climate measure across construction trades." *Accid Anal Prev* 51: 68-77.

The use of safety climate measures for needs assessment and interventions has become increasingly popular. However, no research to date has examined whether the meaning and level of safety climate may differ across different groups of interest. This study used multi-group confirmatory factor analyses to investigate the measurement equivalence of a multidimensional safety climate measure across ten construction trade groups (N=4725). In addition, observed mean differences in safety climate perceptions between trades were examined. Results revealed strong measurement equivalence of the safety climate measure across the construction trade groups. Further, significant mean differences were found between the ten trade groups on all four safety climate scales.

Cigularov, K. P., et al. (2010). "The effects of error management climate and safety communication on safety: a multi-level study." *Accid Anal Prev* 42(5): 1498-1506.

Work in the construction industry is considered inherently dangerous, despite the technological improvements regarding the safety of work conditions and equipment. To address the urgent need to identify organizational predictors of safety performance and outcomes among construction workers, the present study examined multi-level effects of two important indicators of safety climate, namely contractor error management climate and worker safety communication, on safety behavior, injury, and pain among union construction workers. Data were collected from 235 union construction workers employed by 15 contractors in Midwest and Northwest regions of the United States. Results revealed significant main effects for safety communication and error

management climate on safety behaviors and pain, but not on injuries. Our findings suggest that positive safety communication and error management climate are important contributors to improving workplace safety. Specific implications of these results for organizational safety research and practice are discussed.

Cigularov, K. P., et al. (2013). "Measurement equivalence of a safety climate measure among Hispanic and White Non-Hispanic construction workers." *Safety science* 54: 58-68.

Research continues to expose ethnic disparities in safety and health outcomes, making comparative studies of work-related factors that may explain these disparities increasingly important. Such studies raise issues about the cross-ethnic validity of the measures used to assess the factors of interest, such as safety climate. The current study is the first to examine the measurement equivalence of a multidimensional safety climate scale. A multi-group confirmatory factor analytic approach was used to assess the equivalence of the measure across White English-speaking, Hispanic English-speaking, and Hispanic Spanish-speaking construction workers. Results indicated that the same pattern of factors and equivalent factor loadings adequately represented the safety climate items across groups. However, other differences in item parameters were identified, including non-equivalence of some error variances and intercepts. This study highlights the importance of establishing measurement equivalence before proceeding with mean comparisons among groups. Future research should continue to investigate why differences in safety-related perceptions across ethnicities might exist.

Dale, A. M., et al. (2016). "Evaluation of a participatory ergonomics intervention in small commercial construction firms." *Am J Ind Med* 59(6): 465-475.

BACKGROUND: Work-related musculoskeletal disorders (WMSD) among construction workers remain high. Participatory ergonomics (PE) interventions that engage workers and employers in reducing work injury risks have shown mixed results. **METHODS:** Eight-six workers from seven contractors participated in a PE program. A logic model guided the process evaluation and summative evaluation of short-term and intermediate impacts and long-term outcomes from surveys and field records. **RESULTS:** Process measures showed good delivery of training, high worker engagement, and low contractor participation. Workers' knowledge improved and workers reported changes to work practices and tools used; contractor provision of appropriate equipment was low (33%). No changes were seen in symptoms or reported physical effort. **CONCLUSIONS:** The PE program produced many worker-identified ergonomic solutions, but lacked needed support from contractors. Future interventions should engage higher levels of the construction organizational system to improve contractor involvement for reducing WMSD. *Am. J. Ind. Med.* 59:465-475, 2016. (c) 2016 Wiley Periodicals, Inc.

DeArmond, S., et al. (2011). "Individual safety performance in the construction industry: development and validation of two short scales." *Accid Anal Prev* 43(3): 948-954.

In the current research a short measure of safety performance is developed for use in the construction industry and the relationships between different components of safety performance and safety outcomes (e.g., occupational injuries and work-related pain) are explored within the construction context. This research consists of two field studies. In the first, comprehensive measures of safety compliance and safety participation were shortened and modified to be appropriate for use in construction. Evidence of reliability and validity is provided. Both safety compliance and safety participation were negatively related to occupational injuries, yet these two correlations were not statistically different. In the second study, we investigated the relationships between these two components of safety performance and work-related pain frequency, in addition to replicating Study 1.

Safety compliance had a stronger negative relationship with pain than safety participation. Implications for research are discussed.

Diaz Fuentes, C. M., et al. (2016). "Latino immigrant day laborer perceptions of occupational safety and health information preferences." *Am J Ind Med* 59(6): 476-485.

BACKGROUND: We address immigrant day laborers' experiences with occupational safety in the construction industry in New Orleans, and opinions about content and method of communication for educational interventions to reduce occupational risks. **METHODS:** In 2011, we conducted seven focus groups with 48 Spanish-speaking day laborers (8 women, 40 men, 35 years on average). Focus group results are based on thematic analysis. **RESULTS:** Most employers did not provide safety equipment, threatened to dismiss workers who asked for it, and did not provide health insurance. Attitudes toward accepting unsafe work conditions varied. Women faced lower pay and hiring difficulties than men. Day laborers preferred audio format over written, and content about consequences from and equipment for different jobs/exposures. **CONCLUSIONS:** Day laborers have common occupational experiences, but differences existed by gender, literacy and sense of control over safety. Day laborer information preferences and use of media needs further studying. *Am. J. Ind. Med.* 59:476-485, 2016. (c) 2016 Wiley Periodicals, Inc.

Dutra, L. M., et al. (2014). "Worksite safety climate, smoking, and the use of protective equipment by blue-collar building workers enrolled in the Mass BUILT smoking cessation trial." *J Occup Environ Med* 56(10): 1082-1087.

Objective: To assess potential contributors to high injury rates and smoking prevalence among construction workers, we investigated the association of safety climate with personal protective equipment use, and smoking behaviors. **Methods:** Logistic regression models estimated risk ratios for personal protective equipment use and smoking using data from participants in Mass BUILT smoking cessation intervention (n = 1725). **Results:** Contractor safety climate was negatively associated with the use of dust masks (rate ratio [RR], 0.88; 95% confidence interval [CI], 0.83 to 0.94), respirators (RR, 0.82; 95% CI, 0.75 to 0.89), general equipment (RR, 0.98; 95% CI, 0.95 to 1.00), and fall protection (RR, 0.94; 95% CI, 0.91 to 0.98) and positively associated with current smoking (RR, 1.12; 95% CI, 1.01 to 1.25) but not smoking cessation. Coworker safety climate was negatively associated with the use of dust masks (RR, 0.87; 95% CI, 0.82 to 0.92), respirators (RR, 0.80; 95% CI, 0.74 to 0.87), general equipment (RR, 0.96; 95% CI, 0.94 to 0.98), fall (RR, 0.92; 95% CI, 0.89 to 0.96), and hearing protection (RR, 0.88; 95% CI, 0.83 to 0.93) but not smoking. **Conclusions:** Worksite safety climate may be important for personal protective equipment use and smoking, but further research is needed. Copyright © 2014 by American College of Occupational and Environmental Medicine.

Edelson, J., et al. (2009). "Predictors of hearing protection use in construction workers." *Ann Occup Hyg* 53(6): 605-615.

OBJECTIVES: Although noise-induced hearing loss is completely preventable, it remains highly prevalent among construction workers. Hearing protection devices (HPDs) are commonly relied upon for exposure reduction in construction, but their use is complicated by intermittent and highly variable noise, inadequate industry support for hearing conservation, and lax regulatory enforcement. **METHODS:** As part of an intervention study designed to promote HPD use in the construction industry, we enrolled a cohort of 268 construction workers from a variety of trades at eight sites and evaluated their use of HPDs at baseline. We measured HPD use with two instruments, a questionnaire survey and a validated combination of activity logs with simultaneous dosimetry measurements. With these measurements, we evaluated potential predictors of HPD use based on components of Pender's revised health promotion model (HPM) and safety climate factors. **RESULTS:** Observed full-shift

10 Topics in Construction Safety and Health: Safety Culture and Safety Climate

equivalent noise levels were above recommended limits, with a mean of 89.8 +/- 4.9 dBA, and workers spent an average of 32.4 +/- 18.6% of time in each shift above 85 dBA. We observed a bimodal distribution of HPD use from the activity card/dosimetry measures, with nearly 80% of workers reporting either almost never or almost always using HPDs. Fair agreement ($\kappa = 0.38$) was found between the survey and activity card/dosimetry HPD use measures. Logistic regression models identified site, trade, education level, years in construction, percent of shift in high noise, and five HPM components as important predictors of HPD use at the individual level. Site safety climate factors were also predictors at the group level. CONCLUSIONS: Full-shift equivalent noise levels on the construction sites assessed were well above the level at which HPDs are required, but usage rates were quite low. Understanding and predicting HPD use differs by methods used to assess use (survey versus activity card/dosimetry). Site, trade, and the belief that wearing HPD is not time consuming were the only predictors of HPD use common to both measures on an individual level. At the group level, perceived support for site safety and HPD use proved to be predictive of HPD use.

Evanoff, B., et al. (2016). "Results of a fall prevention educational intervention for residential construction." *Safety science* 89: 301-307.

Falls from height remain the leading cause of fatalities in residential construction. We used results from a comprehensive needs assessment to guide changes in fall prevention training in a joint union-contractor carpenter apprenticeship program; including surveys of 1018 apprentice carpenter and observational audits at 197 residential construction sites. The revised training utilized hands-on, participatory training methods preferred by the learners to address the safety gaps in the curriculum; including ladder use, leading edge work, truss setting, and use of scaffolding and personal fall arrest. We compared apprentice surveys ($n = 1273$) and residential worksite audits ($n = 207$) 1–2 years post-training with baseline measures. Apprentices working residential construction were more likely to fall from heights (OR = 2.26, 95% CI 1.59–3.21) than those working commercial construction. The revised training resulted in improved fall safety knowledge, self-reported worksite behaviors, risk perceptions, and safety climate, even after adjusting for temporal trends. We also observed significant improvements in fall safety compliance in most domains of the worksite audit, with larger changes observed in areas emphasized in the training, demonstrating specificity of the effect. Greater effects were noted in small and medium-sized contractors, who often have limited resources to devote to safety. Self-reported falls fell from 18.2 to 14.5 per 100 person-years of work. This research supports growing evidence that worksite safety can be improved by training. This curriculum could be readily adapted to other union apprenticeship programs. Fall safety of inexperienced residential construction workers' should remain a focus of future research. © 2016 Elsevier Ltd

Fulmer, S., et al. (2006). "Factors influencing ergonomic intervention in construction: trunkman case study." *New Solut* 16(3): 235-247.

This case study examines factors affecting the use of equipment designed to prevent lower back strain in laborers who pour concrete on major highway construction sites. Qualitative methods of organizational analysis were used to characterize factors identified from interviews and participant observation. The major obstacles to the use of the control on site were 1. Managers placing a low priority on ergonomics. 2. Safety officers' limited power in organizational hierarchies. 3. Rationalizing, rather than challenging, resistance to change. 4. Lack of a forum to share knowledge about interventions. Several organizational factors impeded the adoption of a technically effective, low-cost safety control on the site studied. The implementation of the control ultimately resulted from actions taken by the investigators, suggesting that safety programs present at the site are not always adequate to realize feasible interventions.

11 Topics in Construction Safety and Health: Safety Culture and Safety Climate

Gilkey, D. P., et al. (2011). "Comparative analysis of safety culture perceptions among homesafe managers and workers in residential construction." *Journal of Construction Engineering and Management* 138(9): 1044-1052.

Construction workers continue to experience high rates of injury and illness compared with many other industries. Growing evidence suggests that safety culture has a direct effect on safety performance. This study investigated measures of safety culture and risk perception among a residential-home-building cohort within the HomeSafe Pilot Program in the Denver metro area of Colorado. Investigators compared group-level responses of management to frontline construction workers. Results indicate that managers appraised the overall safety culture at higher levels compared with the workers. Managers also perceived a higher level of management commitment to safety and health than that reported by workers.

Gillen, M., et al. (2002). "Perceived safety climate, job demands, and coworker support among union and nonunion injured construction workers." *J Safety Res* 33(1): 33-51.

PROBLEM: This study evaluated injured construction workers' perceptions of workplace safety climate, psychological job demands, decision latitude, and coworker support, and the relationship of these variables to the injury severity sustained by the workers. **METHODS:** Injury severity was assessed using the Health Assessment Questionnaire (HAQ), which evaluates functional limitations. Worker perceptions of workplace variables were determined by two instruments: (a) the Safety Climate Measure for Construction Sites and (b) the Job Content Questionnaire (JCQ). **RESULTS:** The overall model explained 23% of the variance in injury severity, with unique contributions provided by union status, the Safety Climate Score, and Psychological Job Demands. A positive significant correlation was found between injury severity and the Safety Climate Scores ($r = .183$, $P = .003$), and between the Safety Climate Scores and union status ($r = .225$, $P < .001$). **DISCUSSION:** There were statistically significant differences between union and nonunion workers' responses regarding perceived safety climate on 5 of the 10 safety climate items. Union workers were more likely than nonunion workers to: (a) perceive their supervisors as caring about their safety; (b) be made aware of dangerous work practices; (c) have received safety instructions when hired; (d) have regular job safety meetings; and (e) perceive that taking risks was not a part of their job. However, with regard to the 49-item JCQ, which includes Coworker Support, the responses between union and nonunion workers were very similar, indicating an overall high degree of job satisfaction. However, workers who experienced their workplace as more safe also perceived the level of management ($r = -.55$, $P < .001$) and coworker ($r = -.31$, $P < .001$) support as being higher. **IMPACT ON INDUSTRY:** The findings of this study underscore the critical need for construction managers to alert workers to dangerous work practices and conditions more frequently, and express concern and praise workers for safe work in a manner that is culturally acceptable in this industry. Workplace interventions that decrease the incidence and severity of injuries, but that are flexible enough to meet a variety of potentially competing imperatives, such as production deadlines and client demands, need to be identified.

Gillen, M., et al. (2004). "Construction managers' perceptions of construction safety practices in small and large firms: a qualitative investigation." *Work* 23(3): 233-243.

BACKGROUND AND GOALS: Despite the institution of explicit safety practices in construction, there continue to be exceedingly high rates of morbidity and mortality from work-related injury. This study's purpose was to identify, compare and contrast views of construction managers from large and small firms regarding construction safety practices. A complementary analysis was conducted with construction workers. **METHODS:** A semi-structured interview guide was used to elicit information from construction managers ($n = 22$) in a series of focus groups. Questions were designed to obtain information on direct safety practices and indirect practices such as communication style, attitude,

12 Topics in Construction Safety and Health: Safety Culture and Safety Climate

expectations, and unspoken messages. Data were analyzed using thematic content analysis. RESULTS: Managers identified a broad commitment to safety, worker training, a changing workplace culture, and uniform enforcement as key constructs in maintaining safe worksites. Findings indicate that successful managers need to be involved, principled, flexible, and innovative. Best practices, as well as unsuccessful injury prevention programs, were discussed in detail. Obstacles to consistent safety practice include poor training, production schedules and financial constraints. CONCLUSIONS: Construction managers play a pivotal role in the definition and implementation of safety practices in the workplace. In order to succeed in this role, they require a wide variety of management skills, upper management support, and tools that will help them instill and maintain a positive safety culture. Developing and expanding management skills of construction managers may assist them in dealing with the complexity of the construction work environment, as well as providing them with the tools necessary to decrease work-related injuries.

Gillen, M., et al. (2004). "Construction workers' perceptions of management safety practices: a qualitative investigation." *Work* 23(3): 245-256.

BACKGROUND AND GOALS: The purpose of this study was to identify perceptions of management safety practices from the viewpoint of union and nonunion construction workers. A complementary investigation was conducted with construction managers. METHODS: A semi-structured interview guide was used to elicit information from 64 workers (95% male) in ten focus groups. Questions were designed to elicit information about management practices that facilitate or discourage safe working conditions, including communication style, attitude, expectations, and unspoken messages. Data were analyzed using thematic content analysis. RESULTS: Workers identified management commitment to safety, concern for workers, congruence between spoken messages and practice, professionalism, and communication skills as key qualities in successful managers. Workers provided vivid examples of excellent and poor management strategies. CONCLUSIONS: Construction managers play a pivotal role in the definition and implementation of safety practices in the workplace and workers look to them for guidance and modeling. Given the high rates of injury in construction, deeply imbedded protective policies that rely on input from a broad range of stakeholders, including construction workers, should be developed.

Gittleman, J. L., et al. (2010). "[Case Study] CityCenter and Cosmopolitan Construction Projects, Las Vegas, Nevada: lessons learned from the use of multiple sources and mixed methods in a safety needs assessment." *J Safety Res* 41(3): 263-281.

PROBLEM: The present study describes a response to eight tragic deaths over an eighteen month times span on a fast track construction project on the largest commercial development project in U.S. history. METHODS: Four versions of a survey were distributed to workers, foremen, superintendents, and senior management. In addition to standard Likert-scale safety climate scale items, an open-ended item was included at the end of the survey. RESULTS: Safety climate perceptions differed by job level. Specifically, management perceived a more positive safety climate as compared to workers. Content analysis of the open-ended item was used to identify important safety and health concerns which might have been overlooked with the qualitative portion of the survey. DISCUSSION: The surveys were conducted to understand workforce issues of concern with the aim of improving site safety conditions. Such efforts can require minimal investment of resources and time and result in critical feedback for developing interventions affecting organizational structure, management processes, and communication. SUMMARY: The most important lesson learned was that gauging differences in perception about site safety can provide critical feedback at all levels of a construction organization. IMPACT ON THE INDUSTRY: Implementation of multi-level organizational perception

13 Topics in Construction Safety and Health: Safety Culture and Safety Climate

surveys can identify major safety issues of concern. Feedback, if acted upon, can potentially result in fewer injuries and fatal events.

Goldenhar, L. M. and P. Stafford (2015). "If you've seen one construction worksite stretch and flex program ... you've seen one construction worksite stretch and flex program." *J Safety Res* 55: 73-79.

BACKGROUND: Work-related Musculoskeletal Disorders (WMSD) account for approximately one-third of all injuries in the U.S. construction industry. Many companies have implemented stretch and flex (s/f) programs to reduce WMSD despite a lack of evidence showing effectiveness. **METHODS:** We conducted a mixed-methods study to understand (a) why employers continue devoting resources to s/f programs; (b) how programs vary; and (c) any actual or perceived benefits. **RESULTS:** Nineteen safety and health professionals were interviewed and 133 more (13.3% response rate) completed an on-line survey. Fifty-six percent had implemented an s/f program with the primary goal of reducing WMSDs; though most did not review data to determine goal achievement. Program structure varied in terms of duration, frequency, and type of stretches. There was strong agreement about mandating attendance but not participation, due primarily to liability issues. Cost was a factor when deciding to implement a program but not for sustaining one. The majority had not implemented other ergonomic prevention activities, but many had started conducting daily safety huddles for task and safety planning. Those reporting a reduction in WMSDs agreed that it was not due to the s/f program alone and that other benefits included increased worker camaraderie, communication, and collaboration. **CONCLUSION:** Although there is little to no scientific evidence showing that they work as intended, construction companies continue to implement s/f programs with the goal of reducing WMSDs. Bringing work crews together for s/f activities has prompted employers to also begin conducting daily safety huddles. Although employers may not be able to link reduced WMSDs to an s/f program, the ancillary benefits may warrant the time and resources. **PRACTICAL APPLICATIONS:** S/f programs should be only one component of a more comprehensive ergonomics prevention program. Conducting daily safety huddles at the same time also may enhance worker communication, camaraderie, collaboration and improve safety outcomes.

Hallowell, M. R. and I. F. Yugar-Arias (2016). "Exploring fundamental causes of safety challenges faced by Hispanic construction workers in the US using photovoice." *Safety science* 82: 199-211.

The US construction industry has long been responsible for a high injury and fatality rate. Within this dangerous industry, Hispanic workers are 45% more likely to be injured or killed than their non-Hispanic counterparts. Previous researchers have examined reasons for these disproportionate injury rates but past literature is spurious, fragmented, and incomplete. To address these limitations an in-depth study was launched to explore the perceived challenges that impact the safety of Hispanic construction workers. The primary data collection method was Photovoice, a photograph-based interview process that allows each participant to be the generator of their own data. The results of Photovoice interviews with 17 Hispanic workers in Colorado indicate that, compared with non-Hispanic workers, Hispanic workers perceive that they are: (1) susceptible to an internal pressure to complete work quickly and neglect safety based on their experiences in their home country; (2) assigned more dangerous tasks because of racism and discrimination; (3) more willing to accept dangerous work for fear of losing their jobs and ability to support extended family; (4) less likely to provide feedback to their supervisors and co-workers for fear of negative personal reactions; (5) more likely to be distracted by family issues while at work because of their strong and broad family ties; (6) more likely to ignore criticism because of machismo; (7) more likely to underreport injuries for fear of losing their jobs; and (8) less likely to ask for safety assistance when it is needed because of pride. © 2015 Elsevier Ltd.

Han, S., et al. (2014). "Toward an understanding of the impact of production pressure on safety performance in construction operations." *Accid Anal Prev* 68: 106-116.

It is not unusual to observe that actual schedule and quality performances are different from planned performances (e.g., schedule delay and rework) during a construction project. Such differences often result in production pressure (e.g., being pressed to work faster). Previous studies demonstrated that such production pressure negatively affects safety performance. However, the process by which production pressure influences safety performance, and to what extent, has not been fully investigated. As a result, the impact of production pressure has not been incorporated much into safety management in practice. In an effort to address this issue, this paper examines how production pressure relates to safety performance over time by identifying their feedback processes. A conceptual causal loop diagram is created to identify the relationship between schedule and quality performances (e.g., schedule delays and rework) and the components related to a safety program (e.g., workers' perceptions of safety, safety training, safety supervision, and crew size). A case study is then experimentally undertaken to investigate this relationship with accident occurrence with the use of data collected from a construction site; the case study is used to build a System Dynamics (SD) model. The SD model, then, is validated through inequality statistics analysis. Sensitivity analysis and statistical screening techniques further permit an evaluation of the impact of the managerial components on accident occurrence. The results of the case study indicate that schedule delays and rework are the critical factors affecting accident occurrence for the monitored project. © 2013 Elsevier Ltd.

Hoffmeister, K., et al. (2014). "The differential effects of transformational leadership facets on employee safety." *Safety science* 62: 68-78.

Transformational and transactional leadership have been associated with numerous positive safety outcomes, such as improved safety climate, increased safety behaviors, and decreased accidents and injuries. However, leadership is a complex, multidimensional construct, and there is reason to suspect that different facets of leadership may affect safety in different ways and for different reasons. Yet little research to date has considered the relationships between individual facets of transformational and transactional leadership and safety outcomes. The present study addressed this gap by using relative weights analysis to examine the unique influences of leadership facets on five employee safety outcomes. In a survey of 1167 construction pipefitters and plumbers, idealized attributes and behaviors accounted for the most variance in each of the safety outcomes, whereas individualized consideration and active management-by-exception frequently accounted for the least amount of variance. These results suggest that leadership development programs in construction should address multiple individual elements of leadership, such as core values, as well as concrete skills and behaviors. © 2013 Elsevier Ltd.

Huang, Y. H., et al. (2006). "Safety climate and self-reported injury: assessing the mediating role of employee safety control." *Accid Anal Prev* 38(3): 425-433.

To further reduce injuries in the workplace, companies have begun focusing on organizational factors which may contribute to workplace safety. Safety climate is an organizational factor commonly cited as a predictor of injury occurrence. Characterized by the shared perceptions of employees, safety climate can be viewed as a snapshot of the prevailing state of safety in the organization at a discrete point in time. However, few studies have elaborated plausible mechanisms through which safety climate likely influences injury occurrence. A mediating model is proposed to link safety climate (i.e., management commitment to safety, return-to-work policies, post-injury administration, and safety training) with self-reported injury through employees' perceived control on safety. Factorial evidence substantiated that management commitment to safety, return-to-work policies, post-injury administration, and safety training are important dimensions of safety climate. In addition, the data

15 Topics in Construction Safety and Health: Safety Culture and Safety Climate

support that safety climate is a critical factor predicting the history of a self-reported occupational injury, and that employee safety control mediates the relationship between safety climate and occupational injury. These findings highlight the importance of incorporating organizational factors and workers' characteristics in efforts to improve organizational safety performance.

Huang, Y. H., et al. (2004). "Worker perceptions of organizational support and return-to-work policy: associations with post-injury job satisfaction." *Work* 23(3): 225-232.

This study evaluates the psychometric properties of an industry-based employee measure of employer responses to injuries (i.e., organizational support and return-to-work policies) and explores the relationship of these variables to post-injury job satisfaction. Survey data were collected from 1438 employees with work-related injuries in 13 construction companies and 13 transportation companies. Factor analyses supported the two-factor structure of the scale, and both organizational support and return-to-work policies were independently associated with post-injury job satisfaction. The results suggest a need for understanding organizational responses to injuries, employee perceptions of injury response, and the impact of both on organizational outcomes.

Jorgensen, E., et al. (2007). "An English/Spanish safety climate scale for construction workers." *Am J Ind Med* 50(6): 438-442.

BACKGROUND: Workers in the construction trades experience high rates of traumatic injury. An increasing number of workers in this industry speak only Spanish, including members of construction trade unions. This brief communication reports a dual language safety climate scale developed during a larger training intervention study. **METHODS:** Construction workers in two unions self-completed a previously validated 6-item safety climate scale modified for the construction trades. A seventh item was developed midway through the study and incorporated into the version completed by half of the respondents. For one union with a sizeable number of Spanish-speaking members, a dual-language (Spanish/English) version was administered. Follow-up telephone interviews conducted 3 months after the self-completed survey also included the safety climate scale. **RESULTS:** Cronbach's coefficient alpha was 0.85 for the 6-item scale and 0.85 for the 7-item scale. Similar coefficient alpha scores were found for the subgroup of Spanish-speakers on the 6- and 7-item scales. Spanish speakers with low education were less likely to respond to the scale when self-completing but not when it was administered by telephone in Spanish. **CONCLUSION:** This safety climate scale elicits consistent and reliable response from unionized construction workers when administered in English or in Spanish. Spanish literacy may be a consideration for the use of this scale among foreign-born Hispanic workers.

Kaskutas, V., et al. (2016). "Foremen's intervention to prevent falls and increase safety communication at residential construction sites." *Am J Ind Med* 59(10): 823-831.

Background: This research aimed to improve residential construction foremen's communication skills and safety behaviors of their crewmembers when working at heights. **Methods:** Eighty-four residential construction foremen participated in the 8-hr fall prevention and safety communication training. We compared pre- and post-intervention surveys from foremen and their crewmembers to measure the effect of training. **Results:** Foremen and crewmembers' ratings showed improvements in fall prevention knowledge, behaviors, and safety communication and were sustained 6-months post-training, with emphasized areas demonstrating larger increases. Ratings were similar between foremen and crewmembers, suggesting that the foremen effectively taught their crew and assigned accurate ratings. Based upon associations between safety behaviors and reported falls observed in prior research, we would expect a 16.6% decrease in the one year cumulative incidence of self-reported falls post-intervention. **Conclusions:** This intervention improved safety knowledge and behaviors of a large number of workers by training construction foremen in fall prevention and safety

communication skills. *Am. J. Ind. Med.* 59:823–831, 2016. © 2016 Wiley Periodicals, Inc. © 2016 Wiley Periodicals, Inc.

Kaskutas, V., et al. (2013). "Fall prevention and safety communication training for foremen: Report of a pilot project designed to improve residential construction safety." *J Safety Res* 44: 111-118.

PROBLEM: Falls from heights account for 64% of residential construction worker fatalities and 20% of missed work days. We hypothesized that worker safety would improve with foremen training in fall prevention and safety communication. **METHOD:** Training priorities identified through foreman and apprentice focus groups and surveys were integrated into an 8-hour training. We piloted the training with ten foremen employed by a residential builder. Carpenter trainers contrasted proper methods to protect workers from falls with methods observed at the foremen's worksites. Trainers presented methods to deliver toolbox talks and safety messages. Results from worksite observational audits (n=29) and foremen/crewmember surveys (n=97) administered before and after training were compared. **RESULTS:** We found that inexperienced workers are exposed to many fall hazards that they are often not prepared to negotiate. Fall protection is used inconsistently and worksite mentorship is often inadequate. Foremen feel pressured to meet productivity demands and some are unsure of the fall protection requirements. After the training, the frequency of daily mentoring and toolbox talks increased, and these talks became more interactive and focused on hazardous daily work tasks. Foremen observed their worksites for fall hazards more often. We observed increased compliance with fall protection and decreased unsafe behaviors during worksite audits. **DISCUSSION:** Designing the training to meet both foremen's and crewmembers' needs ensured the training was learner-centered and contextually-relevant. This pilot suggests that training residential foremen can increase use of fall protection, improve safety behaviors, and enhance on-the-job training and safety communication at their worksites. **IMPACT ON INDUSTRY:** Construction workers' training should target safety communication and mentoring skills with workers who will lead work crews. Interventions at multiple levels are necessary to increase safety compliance in residential construction and decrease falls from heights.

Kaskutas, V., et al. (2010). "Fall prevention among apprentice carpenters." *Scand J Work Environ Health* 36(3): 258-265.

OBJECTIVES: Falls from heights are a leading cause of mortality and morbidity in the construction industry, especially among inexperienced workers. We surveyed apprentice carpenters to identify individual and organizational factors associated with falls from heights. **METHODS:** We developed a 72-item survey on fall prevention with multiple domains including fall experience, fall-prevention knowledge, risk perceptions, confidence in ability to prevent falls, training experience, and perceptions of the safety climate and crew safety behaviors. We administered the questionnaire to apprentice carpenters in this cross-sectional study. **RESULTS:** Of the 1025 respondents, 51% knew someone who had fallen from a height at work and 16% had personally fallen in the past year, with ladders accounting for most of the falls. Despite participation in school-based and on-the-job training, fall-prevention knowledge was poor. Ladders were perceived as low risk and ladder training was rare. Apprentices reported high levels of unsafe, fall-related behaviors on their work crews. Apprentices in residential construction were more likely to fall than those in commercial construction, as were apprentices working on crews with fewer senior carpenters to provide mentorship, and those reporting more unsafe behaviors among fellow workers. **CONCLUSIONS:** Despite participation in a formal apprenticeship program, many apprentices work at heights without adequate preparation and subsequently experience falls. Apprenticeship programs can improve the timing and content of fall-prevention training. This study suggests that organizational changes in building practices, mentorship, and safety practices are also necessary to decrease worker falls from heights.

17 Topics in Construction Safety and Health: Safety Culture and Safety Climate

Kim, S. S., et al. (2014). "Contractor-, steward-, and coworker-safety practice: Associations with musculoskeletal pain and injury-related absence among construction apprentices." *Int Arch Occup Environ Health* 87(5): 493-500.

Objectives: This paper sought to assess organizational safety practices at three different levels of hierarchical workplace structure and to examine their association with injury outcomes among construction apprentices. **Methods:** Using a cross-sectional sample of 1,775 construction apprentices, three measures of organizational safety practice were assessed: contractor-, steward-, and coworker-safety practice. Each safety practice measure was assessed using three similar questions (i.e., on-the-job safety commitment, following required or recommended safe work practices, and correcting unsafe work practices); the summed average of the responses ranged from 1 to 4, with a higher score indicating poorer safety practice. Outcome variables included the prevalence of four types of musculoskeletal pain (i.e., neck, shoulder, hand, and back pain) and injury-related absence. **Results:** In adjusted analyses, contractor-safety practice was associated with both hand pain (OR: 1.27, 95 % CI: 1.04, 1.54) and back pain (OR: 1.40, 95 % CI: 1.17, 1.68); coworker-safety practice was related to back pain (OR: 1.42, 95 % CI: 1.18, 1.71) and injury-related absence (OR: 1.36, 95 % CI: 1.11, 1.67). In an analysis that included all three safety practice measures simultaneously, the association between coworker-safety practice and injury-related absence remained significant (OR: 1.68, 95 % CI: 1.20, 2.37), whereas all other associations became non-significant. **Conclusions:** This study suggests that organizational safety practice, particularly coworker-safety practice, is associated with injury outcomes among construction apprentices. © 2013 Springer-Verlag Berlin Heidelberg.

Kincl, L. D., et al. (2016). "Safety voice for ergonomics (SAVE) project: Protocol for a workplace cluster-randomized controlled trial to reduce musculoskeletal disorders in masonry apprentices." *BMC Public Health* 16: 362.

Background: Masons have the highest rate of overexertion injuries among all construction trades and rank second for occupational back injuries in the United States. Identified ergonomic solutions are the primary method of reducing exposure to risk factors associated with musculoskeletal disorders. However, many construction workers lack knowledge about these solutions, as well as basic ergonomic principles. Construction apprentices, as they embark on their careers, are greatly in need of ergonomics training to minimize the cumulative exposure that leads to musculoskeletal disorders. Apprentices receive safety training; however, ergonomics training is often limited or non-existent. In addition, apprenticeship programs often lack "soft skills" training on how to appropriately respond to work environments and practices that are unsafe. The SAVE program - SAFETY VOICE FOR ERGONOMICS - strives to integrate evidence-based health and safety training strategies into masonry apprenticeship skills training to teach ergonomics, problem solving, and speaking up to communicate solutions that reduce musculoskeletal injury risk. The central hypothesis is that the combination of ergonomics training and safety voice promotion will be more effective than no training or either ergonomics training alone or safety voice training alone. **Methods/design:** Following the development and pilot testing of the SAVE intervention, SAVE will be evaluated in a cluster-randomized controlled trial at 12 masonry training centers across the U.S. Clusters of apprentices within centers will be assigned at random to one of four intervention groups (n = 24 per group): (1) ergonomics training only, (2) safety voice training only, (3) combined ergonomics and safety voice training, or (4) control group with no additional training intervention. Outcomes assessed at baseline, at the conclusion of training, and then at six and 12 months post training will include: musculoskeletal symptoms, general health perceptions, knowledge of ergonomic and safety voice principles, and perception and attitudes about ergonomic and safety voice issues. **Discussion:** Masons continue to have a high rate of musculoskeletal disorders. The trade has an expected increase of 40 % in the number of workers by 2020. Therefore, a vetted

intervention for apprentices entering the trade, such as SAVE, could reduce the burden of musculoskeletal disorders currently plaguing the trade. © 2016 Kincl et al.

Lipscomb, H. J., et al. (2008). "Challenges in residential fall prevention: insight from apprentice carpenters." *Am J Ind Med* 51(1): 60-68.

BACKGROUND: Falls remain a serious source of morbidity and mortality in residential construction despite considerable knowledge of risk factors and prevention strategies. While training is universally viewed as positive, we know little about its effectiveness in preventing residential falls. **METHODS:** A series of focus groups were conducted with union apprentice carpenters (n = 36) at varied levels of training to elicit input on factors that might influence the effectiveness of residential fall prevention training, including hazard awareness, timing of elements of formal instruction, jobsite mentoring, and workplace norms. **RESULTS:** While apprentices identified many residential fall hazards, they voiced little concern about work near unprotected vertical or horizontal openings such as stairwells, window openings or leading edges. On residential jobs, apprentices worked at heights immediately and were often exposed to hazards they had not yet been trained to handle. The quality of mentoring varied tremendously, and things they had been taught in school were often not the norm on these small worksites. Use of fall arrest equipment was uncommon. Job insecurity in this fast-paced work environment influenced behaviors even when apprentices reported knowledge of safe procedures; this was more of a problem for less experienced apprentices. **CONCLUSIONS:** These data provide compelling evidence that apprentices often do not apply safety principles they have been taught in school in the actual work environment, illuminating how attempts to empower workers through training alone can fall short. The findings have policy implications and demonstrate the importance of measuring more than knowledge when evaluating effectiveness of training.

Lipscomb, H. J., et al. (2011). "Buyer beware: personnel selling nail guns know little about dangerous tools." *Am J Ind Med* 54(8): 571-578.

BACKGROUND: Nail gun use is ubiquitous in wood frame construction. Accessibility and decreasing costs have extended associated occupational hazards to consumers. Compelling evidence documents decreased injury risk among trained users and those with tools with sequential triggers. To prevent inadvertent discharge of nails, this safer trigger requires the nose be depressed before the trigger is pulled to fire. The sequential trigger is not required by the Consumer Product Safety Commission (CPSC) or the Occupational Safety and Health Administration (OSHA) nor are there any guidelines for training. **METHODS:** We collected data from personnel at 217 points of sale/rental of framing nail guns in four areas of the country. **RESULTS:** Sales personnel had little understanding of risks associated with use of framing nail guns. Individuals who had used the tool and those working in construction outlets were more likely to be knowledgeable; even so, less than half understood differences in trigger/actuation systems. **CONCLUSIONS:** Consumers, including contractors purchasing for workers, cannot count on receiving accurate information from sales personnel regarding risks associated with use of these tools. The attitudes and limited knowledge of some sales personnel regarding these potentially deadly tools likely contributes to a culture accepting of injury. The findings demonstrate how influences on the culture of construction are not limited to workers, employers, or the places construction gets done.

Lipscomb, H. J., et al. (2013). "Safety, incentives, and the reporting of work-related injuries among union carpenters: "you're pretty much screwed if you get hurt at work"." *Am J Ind Med* 56(4): 389-399.

BACKGROUND: In the high-risk construction industry little is known about the prevalence or effects of programs offering rewards for workers and/or their supervisors for improved safety records or those that punish workers in some way for injury. **METHODS:** We conducted an anonymous survey

of 1,020 carpenter apprentices in three union training programs to document prevalence of their exposure to such efforts. We explored associations between perceptions of the reporting of work-related injury and elements of these programs. RESULTS: Fifty-eight percent (58%; n = 592) reported some safety incentive or negative consequence of work-related injuries on their current jobsite. Reporting of work-related injuries was 50% less prevalent when workers were disciplined for injury experiences. Otherwise, we saw minimal evidence of association between injury reporting practices and safety incentive programs. However, considerable evidence of fear of reprisal for reporting injuries was revealed. Less than half (46.4%) reported that work-related injuries were reported in their current workplace all or most of the time; over 30% said they were almost never or rarely reported. CONCLUSIONS: There are multiple layers of disincentives to the reporting of work-related injuries that hamper understanding of risk and pose threats to workplace safety and productivity. These pressures do not arise in a vacuum and are likely influenced by a host of contextual factors. Efforts that help us understand variation across jobsites and time could be enlightening; such inquiries may require mixed methodologies and should be framed with consideration for the upper tiers of the public health hierarchy of hazard control.

Lipscomb, H. J., et al. (2015). "Non-reporting of work injuries and aspects of jobsite safety climate and behavioral-based safety elements among carpenters in Washington state." *Am J Ind Med* 58(4): 411-421.

Background: Declining work injury rates may reflect safer work conditions as well as under-reporting. Methods: Union carpenters were invited to participate in a mailed, cross-sectional survey designed to capture information about injury reporting practices. Prevalence of non-reporting and fear of repercussions for reporting were compared across exposure to behavioral-based safety elements and three domains of the Nordic Safety Climate Questionnaire (NOSACQ-50). Results: The majority (>75%) of the 1,155 participants felt they could report work-related injuries to their supervisor without fear of retribution, and most felt that the majority of injuries on their jobsites got reported. However, nearly half indicated it was best not to report minor injuries, and felt pressures to use their private insurance for work injury care. The prevalence of non-reporting and fear of reporting increased markedly with poorer measures of management safety justice (NOSACQ-50). Conclusions: Formal and informal policies and practices on jobsites likely influence injury reporting. *Am. J. Ind. Med.* 58:411-421, 2015. © 2015 Wiley Periodicals, Inc.

Marin, L. S., et al. (2015). "Results of a community-based survey of construction safety climate for Hispanic workers." *Int J Occup Environ Health* 21(3): 223-231.

BACKGROUND: Hispanic construction workers experience high rates of occupational injury, likely influenced by individual, organizational, and social factors. OBJECTIVES: To characterize the safety climate of Hispanic construction workers using worker, contractor, and supervisor perceptions of the workplace. METHODS: We developed a 40-item interviewer-assisted survey with six safety climate dimensions and administered it in Spanish and English to construction workers, contractors, and supervisors. A safety climate model, comparing responses and assessing contributing factors was created based on survey responses. RESULTS: While contractors and construction supervisors' (n = 128) scores were higher, all respondents shared a negative perception of safety climate. Construction workers had statistically significantly lower safety climate scores compared to supervisors and contractors (30.6 vs 46.5%, P<0.05). Safety climate scores were not associated with English language ability or years lived in the United States. CONCLUSIONS: We found that Hispanic construction workers in this study experienced a poor safety climate. The Hispanic construction safety climate model we propose can serve as a framework to guide organizational safety interventions and evaluate safety climate improvements.

Marín, L. S. and C. Roelofs (2017). "Promoting Construction Supervisors' Safety-Efficacy to Improve Safety Climate: Training Intervention Trial." *Journal of Construction Engineering and Management* 143(8): 04017037.

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. - See more at: <http://ascelibrary.org/doi/full/10.1061/%28ASCE%29CO.1943-7862.0001330#sthash.bOwqmOhn.dpuf>

McDonald, M. A., et al. (2009). ""Safety is everyone's job:" the key to safety on a large university construction site." *J Safety Res* 40(1): 53-61.

PROBLEM: Construction risk management is challenging. METHOD: We combined data on injuries, costs, and hours worked, obtained through a Rolling Owner-Controlled Insurance Program (ROCIP), with data from focus groups, interviews, and field observations, to prospectively study injuries and hazard control on a large university construction project. RESULTS: Lost-time injury rates (1.0/200,000 hours worked) were considerably lower than reported for the industry, and there were no serious falls from height. Safety was considered in the awarding of contracts and project timeline development; hazard management was iterative. A top-down management commitment to safety was clearly communicated to, and embraced by, workers throughout the site. DISCUSSION AND IMPACT: A better understanding of how contracting relationships, workers' compensation, and liability insurance arrangements influence safety could shift risk management efforts from worker behaviors to a broader focus on how these programs and relationships affect incentives and disincentives for workplace safety and health.

Molenaar, K. R., et al. (2009). "Framework for measuring corporate safety culture and its impact on construction safety performance." *Journal of Construction Engineering and Management* 135(6): 488-496.

This paper presents the results of a structural equation model (SEM) that describes and quantifies the relationships between corporate culture and safety performance. The SEM is estimated using 196 individual questionnaire responses from three companies with better than average safety records. A multiattribute analysis of corporate safety culture characteristics resulted in a hierarchical description of corporate safety culture comprised of three major categories: people, process, and value. These three major categories were decomposed into 54 measurable questions and used to develop a questionnaire to quantify corporate safety culture. The SEM identified five latent variables that describe corporate safety culture: (1) a company's safety commitment; (2) the safety incentives that are offered to field personnel for safe performance; (3) the subcontractor involvement in the

21 Topics in Construction Safety and Health: Safety Culture and Safety Climate

company culture; (4) the field safety accountability and dedication; and (5) the disincentives for unsafe behaviors. These characteristics of company safety culture serve as indicators for a company's safety performance. Based on the findings from this limited sample of three companies, this paper proposes a list of practices that companies may consider to improve corporate safety culture and safety performance. A more comprehensive study based on a larger sample is recommended to corroborate the findings of this study.

Perry, M. J., et al. (2015). "Evaluating Fall Safety Compliance among Skilled Trades in Construction." CPWR Report.

Probst, T. M., et al. (2008). "Organizational injury rate underreporting: the moderating effect of organizational safety climate." *J Appl Psychol* 93(5): 1147-1154.

The goals of this study were (a) to assess the extent to which construction industry workplace injuries and illness are underreported, and (b) to determine whether safety climate predicts the extent of such underreporting. Data from 1,390 employees of 38 companies contracted to work at a large construction site in the northwestern United States were collected to assess the safety climate of the companies. Data from the Occupational Safety and Health Administration (OSHA) logs kept by the contractors allowed for calculation of each company's OSHA recordable injury rate (i.e., the reported injury rate), whereas medical claims data from an Owner-Controlled Insurance Program provided the actual experienced rate of injuries for those same companies. While the annual injury rate reported to OSHA was 3.11 injuries per 100 workers, the rate of eligible injuries that were not reported to OSHA was 10.90 injuries per 100 employees. Further, organizations with a poor safety climate had significantly higher rates of underreporting (81% of eligible injuries unreported) compared with organizations with a positive safety climate (47% of eligible injuries unreported). Implications for organizations and the accuracy of the Bureau of Labor Statistics's national occupational injury and illness surveillance system are discussed.

Puerto, C. L. d., et al. (2014). "Exploratory Study to Identify Perceptions of Safety and Risk among Residential Latino Construction Workers as Distinct from Commercial and Heavy Civil Construction Workers." *Journal of Construction Engineering and Management* 140(2): 04013048.

Latino workers in residential construction currently suffer disproportionately high rates of injuries and fatalities compared to Latino workers in commercial and heavy civil construction. The aim of this study is to investigate possible differences in safety culture and risk perception among Latino construction workers across residential, commercial, and heavy civil construction sectors. Analysis was conducted using 218 survey responses from Latino construction workers collected in the Denver metro and northern Colorado areas. Results suggest that Latino workers in commercial and heavy civil construction share more similar perceptions of safety culture and risk than those in residential construction. Specifically, Latino workers in residential construction were more likely to agree with the statements that (1) work productivity and quality have a higher priority than safety and (2) safety rules and safety procedures are difficult to understand and that dangers present on construction sites cannot cause death. This study enhances the knowledge about the safety culture and risk perceptions of Latino construction workers in all three sectors. Study findings support the hypothesis that differences in safety culture perceptions among Latinos may contribute to differences in injury rates across the three sectors. Specifically, perceptions of a less-supportive safety culture may correlate to higher rates of miscommunication and incorrect assumptions that influence decision making, resulting in disproportionately higher rates of injuries and fatalities in residential construction compared to commercial and heavy civil construction. Such research findings are important because they provide a meaningful context and basis for effective construction worker safety interventions in the future.

R. Kaufman and, B., et al. (2014). "Interactive effects of leader justice and support for safety on safety performance." *Journal of Organizational Effectiveness: People and Performance* 1(3): 296-315.

Rojas, E. M. (2013). "Identifying, recruiting, and retaining quality field supervisors and project managers in the electrical construction industry." *Journal of Management in Engineering* 29(4): 424-434.

Productivity depends upon many factors including motivation, symmetry between assignments and skills, anticipation of technical challenges during tasks, precise instructions, availability of materials and equipment, coordination with other trades, creativity, and emphasis on safety and quality. Good field supervisors and project managers foster such productivity. Over 100 participants ranging from electricians to company owners informed a modified 360 assessment of field supervisors and project managers within the unionized electrical contracting community. Focus group discussions and interviews assessed the beneficial characteristics of field supervisors and project managers. Analysis of these characteristics yielded consistent themes, which became the 12 pillars of successful supervision. Based upon these pillars, effective recruitment and retention strategies for both field supervisors and project managers were developed. © 2013 American Society of Civil Engineers.

Sa, J., et al. (2009). "Comparison of risk factors for falls from height between commercial and residential roofers." *J Safety Res* 40(1): 1-6.

INTRODUCTION: The purpose of this investigation was to compare commercial roofers and residential roofers in terms of their behaviors, beliefs, working conditions, and attitudes toward the use of fall protection devices, which could lead to fall accidents. METHODS: A cross-sectional sample of 252 roofers participated in the survey in the Midwest (Wisconsin, Illinois, Michigan, Indiana, and Iowa). RESULTS: Residential roofers were more likely to fall (prevalence ratio = 2.28, 95% CI = 1.58, 3.29) [corrected] than commercial roofers. Race/ethnicity, company size, work type, existence [corrected] of fall protection programs, enforcement of fall protection device use, actual use of fall protection devices, years of experience as a roofer, and perceived level of safety at roofing sites were [corrected] significantly associated with fall accidents. IMPACT ON INDUSTRY: This study adds insight into fall accidents from roofs in the construction industry and provides industry-specific cautions against fall accidents that can be reflected in regulatory agency implementation.

Sampson, J. M., et al. (2014). "Role of safety stressors and social support on safety performance." *Safety science* 64: 137-145.

Saunders, L. W., et al. (2017). "Developing an inter-organizational safety climate instrument for the construction industry." *Safety science* 98: 17-24.

In the construction industry, recent literature has promoted a design for safety approach that discusses the benefits of considering safety from the very start of the project lifecycle. With this approach, non-construction personnel, such as owners and designers, need to work alongside constructors and subcontractors to consider safety during design and procurement stages of a project. This is a difficult process, particularly with the degree of fragmentation in the industry. Safety climate survey instruments have been developed to identify these sources of fragmentation among stakeholder groups, but most of these tools are directed toward on-site construction personnel. This paper describes the development of an inter-organizational safety climate instrument for measuring attitudes toward safety of construction industry stakeholders including owners, designers, construction managers, and subcontractors. Overall, the measurement model demonstrated a good fit with the data based on a confirmatory factor analysis. Therefore, the survey instrument provides a useful tool

23 Topics in Construction Safety and Health: Safety Culture and Safety Climate

for researchers and practitioners to identify the sources of fragmentation in attitudes of construction project personnel toward worker safety that can affect occupational health and safety within the industry. © 2017

Schwatka, N. V., et al. (2016). "Defining and Measuring Safety Climate: A Review of the Construction Industry Literature." *Ann Occup Hyg* 60(5): 537-550.

Safety climate measurements can be used to proactively assess an organization's effectiveness in identifying and remediating work-related hazards, thereby reducing or preventing work-related ill health and injury. This review article focuses on construction-specific articles that developed and/or measured safety climate, assessed safety climate's relationship with other safety and health performance indicators, and/or used safety climate measures to evaluate interventions targeting one or more indicators of safety climate. Fifty-six articles met our inclusion criteria, 80% of which were published after 2008. Our findings demonstrate that researchers commonly defined safety climate as perception based, but the object of those perceptions varies widely. Within the wide range of indicators used to measure safety climate, safety policies, procedures, and practices were the most common, followed by general management commitment to safety. The most frequently used indicators should and do reflect that the prevention of work-related ill health and injury depends on both organizational and employee actions. Safety climate scores were commonly compared between groups (e.g. management and workers, different trades), and often correlated with subjective measures of safety behavior rather than measures of ill health or objective safety and health outcomes. Despite the observed limitations of current research, safety climate has been promised as a useful feature of research and practice activities to prevent work-related ill health and injury. Safety climate survey data can reveal gaps between management and employee perceptions, or between espoused and enacted policies, and trigger communication and action to narrow those gaps. The validation of safety climate with safety and health performance data offers the potential for using safety climate measures as a leading indicator of performance. We discuss these findings in relation to the related concept of safety culture and offer suggestions for future research and practice including (i) deriving a common definition of safety climate, (ii) developing and testing construction-specific indicators of safety climate, and (iii) focusing on construction-specific issues such as the transient workforce, subcontracting, work organization, and induction/acclimation processes.

Schwatka, N. V. and J. C. Rosecrance (2016). "Safety climate and safety behaviors in the construction industry: The importance of co-workers commitment to safety." *Work* 54(2): 401-413.

BACKGROUND: There is growing empirical evidence that as safety climate improves work site safety practice improve. Safety climate is often measured by asking workers about their perceptions of management commitment to safety. However, it is less common to include perceptions of their co-workers commitment to safety. While the involvement of management in safety is essential, working with co-workers who value and prioritize safety may be just as important. **OBJECTIVE:** To evaluate a concept of safety climate that focuses on top management, supervisors and co-workers commitment to safety, which is relatively new and untested in the United States construction industry. **METHODS:** Survey data was collected from a cohort of 300 unionized construction workers in the United States. The significance of direct and indirect (mediation) effects among safety climate and safety behavior factors were evaluated via structural equation modeling. **RESULTS:** Results indicated that safety climate was associated with safety behaviors on the job. More specifically, perceptions of co-workers commitment to safety was a mediator between both management commitment to safety climate factors and safety behaviors. **CONCLUSIONS:** These results support workplace health and safety interventions that build and sustain safety climate and a commitment to safety amongst work teams. © 2016 - IOS Press and the authors.

Shrestha, P. P. and N. N. Menzel (2014). "Hispanic construction workers and assertiveness training." *Work* 49(3): 517-522.

BACKGROUND: Hispanic (Latino) construction workers experience disparities in occupational death and injury rates in the United States. The cultural value of respect for those in authority may hinder these workers from requesting safe working conditions from supervisors. **OBJECTIVE:** To evaluate whether Hispanic construction workers in Las Vegas, Nevada found assertiveness training more useful than non-Hispanic trainees and whether or not they practiced this behavior at work after the training. **METHODS:** An assertiveness training simulation was part of fall prevention classes offered to area construction workers. Eight weeks after the training, participants were interviewed by telephone about class topics they found most useful and whether or not they had made any subsequent behavior changes at work. **RESULTS:** More than half of the 760 fall prevention trainees completed telephone interviews. A smaller proportion of Hispanic trainees found assertiveness training to be useful (11%) than non-Hispanics (28%) ($p \leq 0.001$). Only 2% of both groups identified practicing assertiveness at work. **CONCLUSIONS:** A large proportion of Hispanic trainees valued other knowledge more highly. They may weigh job security as more important than speaking up about safety issues, which might threaten their employment. Interventions to improve safety should focus instead on improving work safety climate and engineering controls.

Silver, K., et al. (2011). "Genetic susceptibility testing for beryllium: worker knowledge, beliefs, and attitudes." *Am J Ind Med* 54(7): 521-532.

BACKGROUND: We sought to gain insight into workers' knowledge, beliefs, and attitudes on the subject of testing for genetic susceptibility to beryllium. **METHODS:** Five focus groups were held with 30 current and former beryllium workers and nine family members. Audio recordings were transcribed and assessed by hierarchical coding using an inductive approach. **RESULTS:** Some workers were unclear about the distinction between genotoxicity and heritability. A key finding is that they perceived the benefits of a positive test result to be related to enhanced autonomous decision-making. The major concern cited by participants was potential abuse of genetic information by employers. Complete financial separation of a prospective testing entity from the employer was seen as crucial. **CONCLUSIONS:** A window of opportunity exists to create regional partnerships for translational research on genetic susceptibility testing. Such partnerships would involve labor, management, public health scientists, primary care professionals, and other stakeholders. They would be critical to identifying testing strategies that maximize worker autonomy along with the public health advantages of genetic testing.

Sokas, R. K., et al. (2009). "An intervention effectiveness study of hazard awareness training in the construction building trades." *Public Health Rep* 124 Suppl 1: 160-168.

OBJECTIVE: We evaluated knowledge, attitudes, and self-reported work practices among apprentice and journeyman trainees in two construction trades at baseline and three months after participation in two training sessions as part of a 10-hour Occupational Safety and Health Administration hazard awareness training program. We developed preliminary assessment of prior and current training impact, accounting for demographics, trade, and construction site safety climate. **METHODS:** Participants were recruited prior to union-delivered safety training, self-completed a baseline survey prior to class, and completed a follow-up interviewer-administered telephone survey three months later. Discrimination (D) testing evaluated knowledge questions, paired t-tests examined differences in pre- and post-intervention knowledge, and attitude responses were tested with the Wilcoxon signed rank test. Linear regression analysis and logistic regression were used to assess the contribution of different categorical responses to specific sub-questions. **RESULTS:** Of 175 workers

25 Topics in Construction Safety and Health: Safety Culture and Safety Climate

completing the baseline survey, 127 were born in the U.S. and 41 were born in Mexico; 40% of those who reported ethnicity were Hispanic. Follow-up surveys were completed by 92 (53%) respondents and documented significant increases in both fall safety and electrical safety knowledge. The most recent safety climate was associated with improvement in fall safety attitudes (slope = 0.49, $p < 0.005$) when adjusted by country of birth (slope = 0.51, $p < 0.001$). Workers born in Mexico had less formal education than U.S.-born workers and lower baseline knowledge scores, but more positive attitude scores at baseline and greater improvements in attitude at follow-up. CONCLUSION: Knowledge and attitude improvement following a one-hour safety class was measurable at three months in both U.S.-born and Mexican-born construction workers.

Sparer, E. and J. Dennerlein (2017). "Safety Communication & Recognition: From Research to Practice in Construction." *Professional Safety* 62(3): 30.

Sparer, E. H., et al. (2016). "Improving safety climate through a communication and recognition program for construction: a mixed methods study." *Scand J Work Environ Health* 42(4): 329-337.

OBJECTIVES: This study aimed to evaluate the efficacy of a safety communication and recognition program (B-SAFE), designed to encourage improvement of physical working conditions and hazard reduction in construction. METHODS: A matched pair cluster randomized controlled trial was conducted on eight worksites (four received the B-SAFE intervention, four served as control sites) for approximately five months per site. Pre- and post-exposure worker surveys were collected at all sites (N=615, pre-exposure response rate of 74%, post-exposure response rate of 88%). Multi-level mixed effect regression models evaluated the effect of B-SAFE on safety climate as assessed from surveys. Focus groups (N=6-8 workers/site) were conducted following data collection. Transcripts were coded and analyzed for thematic content using Atlas.ti (version 6). RESULTS: The mean safety climate score at intervention sites, as measured on a 0-50 point scale, increased 0.5 points (1%) between pre- and post-B-SAFE exposure, compared to control sites that decreased 0.8 points (1.6%). The intervention effect size was 1.64 (3.28%) (P-value=0.01) when adjusted for month the worker started on-site, total length of time on-site, as well as individual characteristics (trade, title, age, and race/ethnicity). At intervention sites, workers noted increased levels of safety awareness, communication, and teamwork compared to control sites. CONCLUSIONS: B-SAFE led to many positive changes, including an improvement in safety climate, awareness, teambuilding, and communication. B-SAFE was a simple intervention that engaged workers through effective communication infrastructures and had a significant, positive effect on worksite safety.

Sparer, E. H., et al. (2015). "Development of a safety communication and recognition program for construction." *New Solut* 25(1): 42-58.

Leading-indicator-based (e.g., hazard recognition) incentive programs provide an alternative to controversial lagging-indicator-based (e.g., injury rates) programs. We designed a leading-indicator-based safety communication and recognition program that incentivized safe working conditions. The program was piloted for two months on a commercial construction worksite and then redesigned using qualitative interview and focus group data from management and workers. We then ran the redesigned program for six months on the same worksite. Foremen received detailed weekly feedback from safety inspections, and posters displayed worksite and subcontractor safety scores. In the final program design, the whole site, not individual subcontractors, was the unit of analysis and recognition. This received high levels of acceptance from workers, who noted increased levels of site unity and team-building. This pilot program showed that construction workers value solidarity with others on site, demonstrating the importance of health and safety programs that engage all workers through a

reliable and consistent communication infrastructure. © The Author(s) 2015 Reprints and permissions: sagepub.co.uk/journalsPermissions.nav.

Sparer, E. H., et al. (2013). "Correlation between safety climate and contractor safety assessment programs in construction." *Am J Ind Med* 56(12): 1463-1472.

Background: Contractor safety assessment programs (CSAPs) measure safety performance by integrating multiple data sources together; however, the relationship between these measures of safety performance and safety climate within the construction industry is unknown. Methods: Four hundred and one construction workers employed by 68 companies on 26 sites and 11 safety managers employed by 11 companies completed brief surveys containing a nine-item safety climate scale developed for the construction industry. CSAP scores from ConstructSecure, Inc., an online CSAP database, classified these 68 companies as high or low scorers, with the median score of the sample population as the threshold. Spearman rank correlations evaluated the association between the CSAP score and the safety climate score at the individual level, as well as with various grouping methodologies. In addition, Spearman correlations evaluated the comparison between manager-assessed safety climate and worker-assessed safety climate. Results: There were no statistically significant differences between safety climate scores reported by workers in the high and low CSAP groups. There were, at best, weak correlations between workers' safety climate scores and the company CSAP scores, with marginal statistical significance with two groupings of the data. There were also no significant differences between the manager-assessed safety climate and the worker-assessed safety climate scores. Conclusions: A CSAP safety performance score does not appear to capture safety climate, as measured in this study. The nature of safety climate in construction is complex, which may be reflective of the challenges in measuring safety climate within this industry. © 2013 Wiley Periodicals, Inc.

Spector, J. T., et al. (2011). "Burden of work-related knee disorders in Washington State, 1999 to 2007." *J Occup Environ Med* 53(5): 537-547.

OBJECTIVE: To describe the burden of knee work-related musculoskeletal disorders (WMSDs). METHODS: Knee WMSDs were identified using Washington State Fund workers' compensation data from 1999 to 2007 and analyzed by cost, industry, occupation, and claims incidence rates. RESULTS: Knee WMSDs accounted for 7% of WMSD claims and 10% of WMSD costs. The rate of decline in claims incidence rates for knee WMSDs was similar to the rate of decline for all other WMSDs. Industries at highest risk for knee WMSDs included construction and building contractors. Occupations of concern included carpenters and truck drivers in men and nursing aides and housekeepers in women. CONCLUSIONS: Between 1999 and 2007, Washington State Fund knee WMSDs were widespread and associated with a large cost. Identification of specific occupational knee WMSD risk factors in high-risk industries is needed to guide prevention efforts.

Stephenson, C. M. and M. R. Stephenson (2011). "Hearing loss prevention for carpenters: part 1 - using health communication and health promotion models to develop training that works." *Noise Health* 13(51): 113-121.

In phase 1 of a large multiyear effort, health communication and health promotion models were used to develop a comprehensive hearing loss prevention training program for carpenters. Additionally, a survey was designed to be used as an evaluation instrument. The models informed an iterative research process in which the authors used key informant interviews, focus groups, and early versions of the survey tool to identify critical issues expected to be relevant to the success of the hearing loss prevention training. Commonly held attitudes and beliefs associated with occupational noise exposure and hearing losses, as well as issues associated with the use or non-use of hearing

protectors, were identified. The training program was then specifically constructed to positively shape attitudes, beliefs, and behavioral intentions associated with healthy hearing behaviors - especially those associated with appropriate hearing protector use. The goal was to directly address the key issues and overcome the barriers identified during the formative research phase. The survey was finalized using factor analysis methods and repeated pilot testing. It was designed to be used with the training as an evaluation tool and thus could indicate changes over time in attitudes, beliefs, and behavioral intentions regarding hearing loss prevention. Finally, the training program was fine tuned with industry participation so that its delivery would integrate seamlessly into the existing health and safety training provided to apprentice carpenters. In phase 2, reported elsewhere in this volume, the training program and the survey were tested through a demonstration project at two sites.

Stephenson, M. R., et al. (2011). "Hearing loss prevention for carpenters: part 2 - demonstration projects using individualized and group training." *Noise Health* 13(51): 122-131.

Two demonstration projects were conducted to evaluate the effectiveness of a comprehensive training program for carpenters. This training was paired with audiometry and counseling and a survey of attitudes and beliefs in hearing loss prevention. All participants received hearing tests, multimedia instruction on occupational noise exposure/hearing loss, and instruction and practice in using a diverse selection of hearing protection devices (HPDs). A total of 103 apprentice carpenters participated in the Year 1 training, were given a large supply of these HPDs, and instructions on how to get additional free supplies if they ran out during the 1-year interval between initial and follow-up training. Forty-two participants responded to the survey a second time a year later and completed the Year 2 training. Significant test-retest differences were found between the pre-training and the post-training survey scores. Both forms of instruction (individual versus group) produced equivalent outcomes. The results indicated that training was able to bring all apprentice participants up to the same desired level with regard to attitudes, beliefs, and behavioral intentions to use hearing protection properly. It was concluded that the health communication models used to develop the educational and training materials for this effort were extremely effective.

Taylor Moore, J., et al. (2013). "Construction workers' reasons for not reporting work-related injuries: An exploratory study." *Int J Occup Saf Ergon* 19(1): 97-105.

Although under-reporting of work-related injuries by workers is recognized as a significant problem in construction and other industries, little is known about the specific reasons for such occurrences. Qualitative and quantitative methods were used in this study to (a) identify reasons why construction workers may choose not to report work-related injuries, and (b) to investigate the frequency of the identified reasons. Twenty-seven percent of a sample of construction workers (N = 135) indicated that they had failed to report a work-related injury. The most frequent reasons given were related to perceptions of injuries as "small" and "part of the job" as well as fear of negative consequences, which may follow injury reporting. These findings are discussed in terms of practical implications. Strategies to overcome these reasons are suggested to decrease the under-reporting of injuries in the construction industry. © 2013, Taylor & Francis Group, LLC. All rights reserved.

Wei, N. (2012). "Five Bad Environmental and Safety Decisions Leading to Catastrophic Results." *Environmental Claims Journal* 24(3): 245-259.

A power plant hired a painting contractor with a poor safety record history. Five painters perished in a fire when the contractor failed to adhere to OSHA's safety standards. The power plant faced criminal charges. Although later acquitted, the company had to pay millions in restitution and endure a public trial. A refinery with a major air permit operated without an environmental staff and endangered its neighbors and workers. Executives pleaded guilty to criminal charges. Another oil

refinery failed to implement its own internal EHS audit findings months before a catastrophic explosion that killed fifteen employees and injured hundreds. © 2012 Copyright Taylor and Francis Group, LLC.

Welton, M., et al. (2017). "Ethnic Disparities of Perceived Safety Climate Among Construction Workers in Georgia, 2015." *J Racial Ethn Health Disparities*.

BACKGROUND: Safety climate involves worker perception about the relative importance where they work and safety climate and has been shown to be a reliable predictor of safety-related outcomes. **METHODS:** The primary objective of this study is to investigate ethnic differences in perceived safety climate among construction workers. Surveys (n = 179) that included a 10-item safety climate scale were administered in Athens, Georgia (GA), at local construction sites and home improvement stores during June-August, 2015. **RESULTS:** The majority of respondents were carpenters or roofers (39%), followed by laborers (22%), painters and dry wall workers (14%), other skilled trades (14%), and supervisors (11%); 32% were Hispanic. Hispanic ethnicity ($p < 0.0001$), drinking two or more alcoholic beverages per day ($p < 0.0001$), working for a company that does not provide health insurance ($p = 0.0022$), and working for a company with fewer than ten employees ($p < 0.0001$) were significantly associated with lower perceived safety climate scores. **CONCLUSION:** The lower perceived safety climate scores among Hispanic workers indicate that the perception of the importance of safety on the job site is lower among Hispanics construction workers than non-Hispanics construction workers.

Williams, Q., Jr., et al. (2010). "The impact of a peer-led participatory health and safety training program for Latino day laborers in construction." *J Safety Res* 41(3): 253-261.

BACKGROUND: Immigrant Latino day laborers working in residential construction are at particularly high risk of fatal and non-fatal traumatic injury and benefit from targeted training. **OBJECTIVE:** To understand the impact of a participatory, peer-facilitated health and safety awareness training customized to the needs of Latino day laborers. **METHODS:** Baseline surveys exploring exposures, PPE use, attitudes, work practices and work-related injuries were collected from more than 300 New Jersey Latino day laborers in construction prior to their participation in a one day (minimum of six hour) Spanish language health and safety training class. The classes, led by trained worker trainers, engaged participants in a series of tasks requiring teamwork and active problem solving focused on applying safe practices to situations they encounter at their worksites. Follow-up surveys were difficult to obtain among mobile day laborers, and were collected from 70 men (22% response rate) 2-6 months following training. Chi-square analysis was used to compare pre- and post-intervention PPE use, self protective actions, and self-reported injury rates. Focus groups and in-depth interviews addressing similar issues provided a context for discussing the survey findings. **RESULTS:** At baseline, the majority of day laborers who participated in this study reported great concern about the hazards of their work and were receptive to learning about health and safety despite limited influence over employers. Changes from baseline to follow-up revealed statistically significant differences in the use of certain types of PPE (hard hats, work boots with steel toes, safety harnesses, and visible safety vests), and in the frequency of self-protective work practices (e.g., trying to find out more about job hazards on your own). There was also a suggestive decrease in self-reported injuries (receiving an injury at work serious enough that you had to stop working for the rest of the day) post-training based on small numbers. Sixty-six percent of workers surveyed post-training reported sharing information from their safety workbook with friends and co-workers. Focus groups and interview results generally confirmed the quantitative findings. **CONCLUSIONS:** Participatory, peer led training tailored to the needs of construction day laborers may have a positive effect on Latino immigrant workers' attitudes, work practices, and self reported injury rates, but major changes would require employer engagement. **IMPACT ON INDUSTRY:** Health and safety researchers have identified reducing the number of

traumatic injuries among the immigrant construction workforce as an increasingly important priority. This project provides one model for collaboration between university-based researchers, a union, and a community-based organization. The specific elements of this project-participatory curriculum customized to the needs of day laborers in residential construction, training day laborers to facilitate training classes, and involving peer leaders in outreach and research-could be adapted by other organizations. The findings of this study suggest that the Latino day laborers have a strong interest in and some ability to act on health and safety information. Widespread implementation of this type of training, especially if supported with cooperation from residential contractors, could lead to reduced rates of traumatic injury in the residential construction industry.

Winn, G. L., et al. (2004). "Fall protection incentives in the construction industry: literature review and field study." *Int J Occup Saf Ergon* 10(1): 5-11.

Safety literature confirms that incentives such as money or sunglasses seem to improve safety conditions over the short run. However, no studies could be found which tested the effect of incentives on fall protection for a period longer than a few days. In our research we found that after 6 months, the use of non-material incentives significantly improved on-time delivery and completion rates of a special inspection form (both $p < .005$). In addition, a questionnaire with embedded critical questions showed that even though workers said that they preferred material incentives, we conclude that their behavior was changed by the treatment (incentives). We further conclude that the use of natural reinforcers seems to influence worker behaviors and perception of management's commitment to safety over the long run, even though workers still say that they prefer tangible rewards. Future work should replicate these findings and explore why workers respond to natural incentives but express a preference for material incentives.

Zhang, P., et al. (2015). "Work-Health and Safety-Risk Perceptions of Construction-Industry Stakeholders Using Photograph-Based Q Methodology." *Journal of Construction Engineering and Management* 141(5): 04014093.

Work health and safety (WHS) on construction sites can be influenced by decisions made upstream from the construction stage. The effectiveness of WHS risk management relies on decision makers' ability to decide appropriate strategies to mitigate/control risks. However, it is unclear whether upstream decision makers share similar WHS risk perceptions with those who undertake the construction work. This study used Q methodology to explore WHS risk perceptions of architects, engineers, construction managers, and WHS professionals. Photographs depicting different technologies/methods were used to capture professionals' WHS risk judgments. Data were analyzed to identify the within-group and between-group similarity/difference in professionals' WHS risk perceptions. The data-analysis result indicates the coexistence of within-group difference and similarity, as well as between-group difference and similarity in WHS risk perceptions. The research contributes to the body of knowledge by showing that WHS risk is subjective in nature and that social, psychological, and technical factors interact to shape subjective risk judgments. The research finding challenges traditional risk-management thinking, which assumes risk is objective and easily quantifiable.

Zhao, D., et al. (2016). "Integrating safety culture into OSH risk mitigation: a pilot study on the electrical safety." *Journal of Civil Engineering and Management* 22(6): 800-807.

Efforts have been taken for years to minimize the occupational safety and health (OSH) risk, but the injury records remain a constant reason for worldwide concerns. Many firms often implement technology as an administrative hierarchy of control (HOC). However, technologies may also actively influence safe practices at the managerial level for administrative HOC. This research examines

electrical safety hazards in the U.S. construction industry as a basis for, studying the feasibility of using technology to integrate safety culture into the administrative level of OSH risk mitigation. The researchers introduce the concept of “habitus”, which suggests one possibility for establishing a safety culture that increases workers’ safety performance and integrates into workers’ safety practices through cutting-edge information technology. A prototype application for OSH training based on mobile virtual reality (MVR) technology is demonstrated to help establish habitus in workers’ daily practices, and ultimately to mitigate OSH risks at the administrative level of construction projects. Results from a preliminary validation test strongly support human behavior influence and safe work knowledge comprehension by the prototyped application. Although this prototype is demonstrated as a pilot study of electrical safety, the application is not limited to this area and is scalable to other OSH risks. © 2016 Vilnius Gediminas Technical University (VGTU) Press.

