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Preliminary Findings on Stretch and Flex (SF) Program and Work-related Musculoskeletal Disorders

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Abstract: The objective of this pilot study is to assess the impact of Stretch and Flex (SF) program implementation on construction worker safety and health, by comparing the difference in a construction firm's work-related musculoskeletal disorders (WMSDs) injury rate before and after the implementation of workplace SF programs. A quantitative research approach was adopted for the study. This involved the development and distribution of a short questionnaire as the survey mechanism. The participants were thirteen construction firms mostly based in the Western United States with construction trades/specialties in carpenters, electricians, operators, sheet metal workers, laborers, plumbers/pipe fitters, cement masons, finishers, teamsters, demolition, landscapes, mason, pile bucks, and millwright. All the companies that responded had written Safety and Health and Stretching & Flex programs. Sprain/strain was the most frequent injury type followed by cuts, rotator cuff injury, back injury, tendinitis, epicondylitis, and CTS, due to overexertion, motion/position, slip/trip, tools/machinery, lifting improperly, and wear/tear. The information on pre vs. post stretch and flex (SF) program implementation and safety performance (numbers of WMSD injuries, OSHA recordable and lost workdays injuries) was analyzed. According to preliminary results, the incident rates of injuries on pre vs. post stretch and flex program implementation indicated that work-related musculoskeletal disorders can be reduced by implementing SF programs.

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1. Introduction

Work-related musculoskeletal disorders (WMSDs) are injuries of the muscles, tendons, joints, and nerves caused or aggravated by work. These can include carpal tunnel syndrome, tendinitis, rotator cuff injuries, epicondylitis, sprains/strains, and back injuries (OSHA, 2016). Workers in construction can be exposed to occupational risk factors at work, such as lifting heavy construction materials, bending, reaching overhead, pushing and pulling heavy loads, working in awkward body postures and performing the same or similar tasks repetitively. WMSDs are among the most frequently reported causes of lost or restricted work time. According to the Bureau of Labor Statistics (BLS), musculoskeletal disorders cases accounted for 33% of all worker injury and illness cases (BLS, 2014). The physically demanding nature of construction work helps explain why strains and sprains are the most common type of injury resulting in days away from work in construction. Ergonomic solutions may help to reduce overexertion and, therefore, the risk of WMSDs. Ergonomic solutions aim to reduce or eliminate ergonomic risk factors with the help of engineering or administrative controls (Choi & Woletz, 2010). Engineering controls typically involve redesigning a workstation or a process to reduce the ergonomic risk factors. Administrative controls include rotating workers through a particular workstation to effectively reduce the exposure to an ergonomic risk factor (Choi & Woletz, 2010). Workplace stretching program can be an example of administrative control. Stretching programs are intended to reduce the incidence and/or severity of injuries by increasing flexibility. Flexibility is commonly defined as the range of movement possible around a specific joint or series of joints, and this definition is applied in most clinical studies. It is a common belief that workers who are less flexible are more likely to have musculoskeletal pain and resultant injury. The presumption is that, for individuals with short or "tight" muscles, stretching exercises increases flexibility by elongating tissues to a more physiologically normal range, promoting optimal function and reducing the risk of musculoskeletal injury (Hess & Hecker, 2003).

Stretching programs are commonly referred to "Stretch and Flex (SF)" in the construction industry. There is a growing interest in, and use of, SF programs to reduce the risk of WMSDs by construction contractors and workers. Even though, the construction industry has been slow to adopt comprehensive ergonomic solutions (The Center for Construction Research and Training, 2011), several construction companies in the United States have instituted a SF program as part of their work place safety and health program (Rajendran & Gambatese, 2009). WMSD can be caused from a multitude of factors including overexertion, incorrect lifting methods, contact with equipment, as well as falls (Costa & Vieira, 2008). Companies who have a high prevalence of WMSD would benefit from a comprehensive ergonomics program that includes administrative and engineering controls which incorporates a stretching program (Graham, 2013). Differences in job tasks and activities equates a need for different types and intensity of stretches. Various studies have shown a correlation between orienting the different job tasks or activities of the worker to different types and intensity of stretching (Gartley & Prosser, 2011; Witvrouw et al., 2004). Choi and Rajendran (2014) identified the perceptions of construction workers on the effectiveness of stretching programs in preventing work-related musculoskeletal disorders. The construction workers participated in the study commonly perceived that the "Stretch and Flex (SF)" program helped prevent work-related musculoskeletal disorders. Workers also perceived there were other SF program benefits such as increased alertness and focus, communication, team building, improved flexibility, and safety planning (Choi & Rajendran, 2014). Another survey study was conducted to look at the perceived benefits of stretch/flex programs, associated costs with such, as well as how stretch/flex programs are typically structured (Goldenhar & Stafford, 2015). The study also consisted of interviews with construction safety and health professionals and found that a stretch program's effectiveness could be partly attributable to other benefits other than stretching such as increased worker camaraderie, collaboration, and communication (Goldenhar & Stafford, 2015). Previous studies have been designed to look at the benefits of stretch/flex programs and prevention of WMSD injuries but have inconclusive or varying results (Costa & Vieira, 2008; McHugh & Cosgrave, 2009). Further studies are necessary to address varying occupational groups undergoing different tasks and the effectiveness of a stretch and flex (SF) program in preventing work-related musculoskeletal injuries and disorders.

1.1 Study Objective

The objective of this pilot study is to assess the impact of Stretch and Flex (SF) program implementation on construction worker safety and health, by comparing the difference in a construction firm's work-related musculoskeletal disorders (WMSDs) injury rate before and after the implementation of workplace SF programs. The study primarily adopted a quantitative research approach to collect data from construction firms in the Western United States.

2. Methods

The research method involved the development and delivery of a survey questionnaire. The survey consisted of four sections requesting information about:

(1) Survey participants and their demographics,
(2) Stretching and flex program Information,
(3) Survey participant injury and illness information, and
(4) Survey participant safety performance three years pre and post SF program implementation.

The authors used the first section to gather information about the participant firm demographics. It included, for example, employer type (owner, general contractor, or subcontractor), area of construction specialization (electrical, mechanical, structural steel, etc.), annual revenues, project type (education, healthcare, etc.), project delivery method, contract delivery method, etc.

The second section generated data about specifics about the participant SF Program using the following questions, for example:

- When did your company implement an SF Program?
- What prompted your company to start stretch and flex (SF) program?
- Based on your company's experience does SF prevent soft-tissue injuries?
- Based on your company's experience with SF program do you think SF reduces the severity of soft-tissue injuries?
- How did your company create or develop the SF program?

The third section requested information about the general injury/illness of participant firm. The fourth and final section solicited information on the participant firm safety performance pre and post-SF program (three years pre and post) implementation. For the purposes of the study, safety performance was measured using the WMSDs rate (WR), OSHA recordable incident rate (TRIR) and lost time case incident rate (LTCR) pre and post SF program implementation.

The participants targeted for the research were primarily construction firms in the Western United States, who also performed work in other parts of the country. The construction firms that have implemented a mandatory SF program within the last ten years were the selection criteria. The authors sent the online questionnaires via email to safety professionals working at these firms. The authors requested them to respond to the questions based on their firms' experience with the SF program implementation at their firms. The duration of the data collection was from May 2015 to December 2015. The Human Subjects Review committee affiliated to the author's institution reviewed and approved the study. Statistical analysis for descriptive statistics and t-tests of the data were conducted using SAS9.3. Incidence rates of injuries (cases per 100 full-time workers) in a given year were computed from the following formula (1).

$$Incident\ rate = \frac{Number\ of\ injuries \times 200{,}000}{Employee\ hours\ worked} \quad (1)$$

3. Results and Discussion

3.1 Participants

The thirteen participants, construction firms in the Western US, employed crafts from 16 different specialties (e.g., carpenters, electricians, operators, sheet metal workers, laborers, plumbers/pipe fitters, cement masons, finishers, teamsters, demolition, landscapes, mason, pile bucks, & millwright). The annual revenues of the firms ranged from $95 million to $6 billion. The types of project delivery methods typically used by the companies were design-build, design-bid-build, CM-at-risk, hard bid, GMP, and design assist. Majority of the participants (77%) were union shops. The numbers of employees employed in the participating companies ranged from 75 – 2000 employees, and the areas of construction specialization were highway/bridges/roads, education/school, government, commercial, healthcare, concrete structures, and heavy civil.

3.2 SF Program Information

All the companies that responded had written Safety and Health and Stretching & Flex (SF) programs while only five had "Ergonomics" programs. Based on their experience with SF programs, 62% of the respondents thought that SF reduced the severity of WMSD injuries, and 46% reported that SF prevented WMSD injuries. Table 1 listed what prompted the companies to start stretch and flex (SF) programs, how they created or developed the SF programs, and how workers are

trained on SF program, respectively. About two-thirds of the companies trained all of their workers on SF programs and about one third of them had a "warm up" requirement before starting to perform SF exercises. The "warm up" sessions were reported to be less than 10 minutes. The workers did the stretch and flex exercises mostly before/beginning of shift/task or in the morning in a typical day. About the half of the companies had stretch and flex exercises tailored to their job duties/trades. About two thirds of the responders reported that the exercise period was adequate (e.g., 10-15 minutes per session). About two-thirds of these leaders were trained in stretch and flex. The majority of the companies (85%) monitored compliance with the stretch and flex, and most of the workers complied with the program.

Table 1. Stretch and Flex (SF) Program.

Prompted to Start SF Program	Back Injuries, Frequency / severity of soft tissue injuries, High Incident Rate, Industry trend, Positive feedback, belief that it would assist us in preventing and reducing injuries, increasing the insurance premiums
How SF Program Created/Developed	Applied a basic program, Assistance from insurance company, Borrowed from another AGC contractor, Copied other companies, Started by daily group safety meetings, Web research
How workers are trained on SF program	New hire orientation, Employee orientation, job site safety meetings, Foreman instruct during daily morning, After a tail gate meeting, employees gather in a circle and are instructed by the foreman to perform certain stretches, PowerPoint, field, subject matter experts, Verbal Instruction from a Physical Therapist/Flyer, outside consultant

3.3 Injury and Illness

Sprain/Strain was the most frequent injury type followed by cuts, rotator cuff injury, back injury, tendinitis, epicondylitis, and carpal tunnel syndrome (CTS) (Fig. 1). Back injury, sprain/strain, rotator cuff injury, and CTS were frequently reported as the most severe (in terms of dollar cost) injury or illness. These injuries or illnesses typically happened by overexertion, motion/position, slip/trip, tools/machinery, lifting improperly, and wear/tear-degenerative (Fig 2). Reported ranks of the body parts as to the frequency at which injuries and illnesses occur were: 1) hand/fingers, 2) back, 3) shoulders, foot/ankle (tie), 5) eyes, 6) knees, and 7) head/neck. Reported ranks of when the employees were most likely to get injured upon employment at their companies were: 1) < 3 months, 2) 3-11 months, 3) >5 years, and 4) 1-5 years.

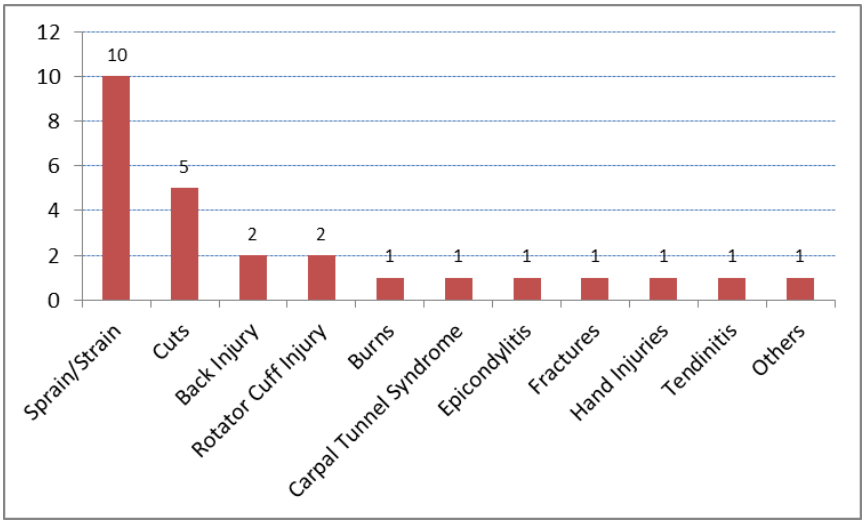

Figure 1. Injury Type.

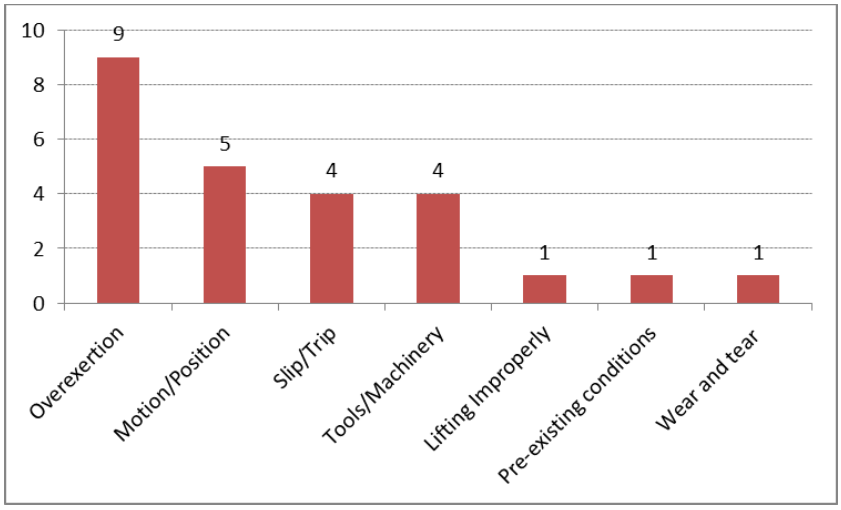

Figure 2. Injury Source/Cause.

3.4 SF Program Implementation

The information on pre vs. post stretch and flex (SF) program implementation and safety performance was collected and analyzed (Years, Total worker hours, No. of WMSD injuries, No. of OSHA recordable injuries, and No. of OSHA lost workday injuries). The incidence rates of injuries were calculated respectively. The normalized injury rates were the average rates of the 1-3 years before the baseline (the year SF program implemented) and the average rates of the 1-3 years after the baseline. There were significant differences in all three average injury rates (no. of WMSD injuries, no. of OSHA recordable injuries, and no. of OSHA lost workday injuries) before and after implementation of SF programs. A paired-samples t-test was conducted to compare normalized average injury rates in 1-3 years before the baseline and 1-3 after the baseline conditions. There were statistically significant differences in all three injury rates. There was a significant difference in the average number of WMSD injuries for 1-3 years before the baseline (Mean = 2.9) and 1-3 years after the baseline (Mean = 1.4). There was a significant difference in the average number of OSHA recordable injuries for 1-3 years before the baseline (Mean = 6.6) and 1-3 years after the baseline (Mean = 3.4). There was a significant difference in the average number of OSHA lost workday injuries for 1-3 years before the baseline (Mean = 1.5) and 1-3 years after the baseline (Mean = 0.6). These results suggest that stretch and flex (SF) programs have an effect on injury rates. Our preliminary findings suggest that the rates of work-related musculoskeletal disorders can be decreased by implementing the SF programs in the workplace.

4. References

Bureau of Labor Statistics (BLS) (2014). Economic News Release: Nonfatal Occupational Injuries and Illnesses Requiring Days Away From Work. US Department of Labor. Retrieved from: http://www.bls.gov/news.release/osh2.nr0.htm

Center for Construction Research and Training (2011). Musculoskeletal Disorders in Construction and Other Industries. Retrieved from: http://cpwr.com/rp-chartbook31-50.html.

Choi, S.D. & Rajendran, S. (2014). Construction workers' perception of stretch and flex program effectiveness in preventing work-related musculoskeletal disorders. Proceedings of the XXVI Occupational Ergonomics and Safety Conference, El Paso, TX, pp. 19-25.

Choi, S.D., & Woletz, T. (2010). Do stretching programs prevent work-related musculoskeletal disorders? *Journal of Safety, Health and Environmental Research*, 2010; 6: 1-19.

Costa, B., & Vieira, E. (2008). Stretching to reduce work-related musculoskeletal disorders: A systematic review. *Journal of Rehab Med*, 2008; 40: 321-328.

Gartley, R. M., & Prosser, J. L. (2011). Stretching to Prevent Musculoskeletal Injuries. *AAOHN Journal*, 2011; 59: 247-252.

Graham, D. (2013). Workplace Stretching Programs: Do They Work and Are They Worth the Cost? *EHS Today*, 2013: 1-2.

Goldenhar, L. M., & Stafford, P. (2015). If you've seen one construction worksite stretch and flex program … you've seen one construction worksite stretch and flex program. *Journal of Safety Research,* 2015; 55: 73-79.

Hess, J.A., & Hecker, S. (2003). Stretching at work for injury prevention: Issues, evidence, & recommendations. *Applied Occ & Environmental Hygiene,* 2003; 18: 333-338.

McHugh, M. P., & Cosgrave, C. H. (2009). To Stretch or not to Stretch: The Role of Stretching in Injury Prevention and Performance. *Scandinavian Journal of Medicine & Science in Sports,* 2009; 20: 169-181.

OSHA (2016). Safety and Health Topics: Prevention of Musculoskeletal Disorders in the Workplace. U.S. Department of Labor. Occupational Safety & Health Administration. Retrieved from: https://www.osha.gov/SLTC/ergonomics/

Rajendran, S., & Gambatese, J.A. (2009). Development and Initial Validation of Sustainable Construction Safety and Health Rating System. *Journal of Construction Engineering and Management,* 2009; 135: 1067-1075.

Witvrouw, E., Mahieu, N., Danneels, L., & Mcnair, P. (2004). Stretching and Injury Prevention. *Sports Medicine,* 2004: 34: 443-449.