Stretch & Flex Programs

Effects on the Reduction of Musculoskeletal Disorders & Injuries

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IN BRIEF
- This study evaluated the impact of stretch-and-flex (SF) programs on construction worker safety and health by comparing construction firms' safety performance/injury rates before and after the implementation of workplace SF programs.
- Sprain/strain was the most frequent musculoskeletal disorder (MSD) injury type followed by rotator cuff injury, back injury, tendinitis, epicondylitis and carpal tunnel syndrome due to overexertion, motion/position, tools/machinery, lifting improperly and wear/tear.
- The authors analyzed information on pre- and post-SF program implementation and safety performance (i.e., number of MSDs, OSHA-recordable injuries, lost-workday injuries).
- Data suggest that work-related MSDs and injuries can be reduced by implementing SF programs.

Workers in construction often face occupational risk factors 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. According to Bureau of Labor Statistics (2016), musculoskeletal disorder (MSD) cases account for one-third of all worker injury and illness cases. Work-related MSDs (WMSDs), injuries of the muscles, tendons, joints and nerves caused or aggravated by work, are among the most frequently reported causes of lost or restricted work time. WMSDs can include carpal tunnel syndrome, tendinitis, rotator cuff injuries, epicondylitis, sprains/strains and back injuries (OSHA, 2016).

The physically demanding nature of construction work helps explain why musculoskeletal injuries and disorders are the most common type of injury resulting in days away from work in construction. Companies that have a high prevalence of WMSDs could benefit from a comprehensive ergonomics program that includes engineering and administrative controls (Choi & Woletz, 2010; DaCosta & Vieira, 2008; Graham, 2013; Hess & Hecker, 2003). Engineering controls typically involve redesigning a workstation or a process to reduce the ergonomic risk factors. A workplace stretching program is an example of an 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; this definition is applied in most clinical studies. It is commonly believed 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 increase 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 as *stretch and flex* (SF). Interest in and use of SF programs to reduce the WMSD risk have grown among construction contractors and workers. Although the construction industry has been slow

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to adopt comprehensive ergonomic solutions (CPWR, 2013), anecdotal data suggest that several construction companies in the U.S. have instituted SF programs as part of their workplace safety and health programs.

In a construction worker safety study, Rajendran and Gambatese (2009) found that 8 of the 11 firms studied implemented an SF program. Differences in job tasks and activities equate to a need for different types and intensity of stretches. Various studies have shown a correlation between orienting the different job tasks or activities to different types and intensity of stretching (Gartley & Prosser, 2011; Witvrouw, Mahieu, Danneels, 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. They found that workers commonly perceived that SF programs helped prevent WMSDs. Workers also perceived other SF program benefits such as increased alertness and focus, communication, team building, improved flexibility and safety planning (Choi & Rajendran, 2014).

Moore's (1998) research on stretching programs at a pharmaceutical manufacturing facility found that participants experienced an increase in flexibility and physical self-perceptions (e.g., body attractiveness, physical conditioning, overall self-worth).

A study of computer workstations that examined the effects of stretching on the prevention of upper limb disorders among computer operators reported an improvement on the function of the arm muscles (Jepsen & Thomsen, 2008). NIOSH researchers examined the effects of rest breaks and stretching exercises on symptoms and performance of data-entry workers. They recommended further research on stretching exercises and exercise compliance (Galinsky, Swanson, Sauter, et al., 2007).

Goldenhar and Stafford (2015) examined the perceived benefits of SF programs, associated costs and how SF programs are typically structured. The study, which consists of interviews with construction safety and health professionals, found that a stretch program's effectiveness could be partly attributed to benefits other than stretching, such as increased worker camaraderie, collaboration and communication (Goldenhar & Stafford, 2015).

The present study aimed to evaluate the impact of an SF program on construction worker safety and health by comparing construction firms' safety performance/injury rates before and after the implementation of workplace SF programs.

Methodology

The research method involved the development and delivery of a survey questionnaire that the authors developed based on their combined professional and research experience in the construction safety discipline. First, the survey questionnaire was piloted to three OSH professionals in the construction safety and health discipline whose companies have implemented mandatory SF programs. Two study participants worked for a general contractor, while the third worked for a specialty contractor. Participants were selected deliberately to ensure that they were from diverse backgrounds.

The pilot study helped the researchers assess the clarity of the survey and its accompanying directions, as well as the possibility of obtaining the data requested in the survey. Suggested revisions from the pilot study were considered and incorporated

TABLE 1

Companies' Involvement With SF Programs

Question	Responses
What prompted SF program implementation?	•back injuries •frequency/severity of soft-tissue injuries •high incident rate •industry trend •positive feedback •belief that it would help prevent and reduce injuries •increasing insurance premiums
How are workers trained on the SF program?	•new-hire/employee orientation •job-site safety meetings •foreman instructs during daily morning meeting •after tailgate meeting, employees gather in a circle and are instructed by foreman to perform certain stretches •PowerPoint •field, subject-matter experts •verbal instruction from a physical therapist/flyer, outside consultant
How was the SF program created/developed	•applied a basic program •assistance from insurance company •borrowed from another Associated General Contractor (AGC) (with help from AGC) •copied other companies •created then used Washington State Department of Labor and Industries program •started by daily group safety meetings •supervisor training •web research •with help from PT Northwest and Proactive Injury Solutions

where possible. For example, the pilot survey requested data for 5 years before and after SF program implementation. Based on the pilot study feedback, the data requested was reduced to 3 years.

The final survey consisted of four sections requesting information about:

1) survey participants and their demographics;
2) SF program information;
3) injury and illness information;
4) safety performance 3 years before and after SF program implementation.

The authors used the first section to gather demographic information about the participant firms. This included employer type (e.g., owner, general contractor, subcontractor), area of construction specialization (e.g., electrical, mechanical, structural steel), annual revenue, project type (e.g., education, healthcare), project delivery method and contract delivery method.

The second section used several questions to generate data about the specifics of the participant SF program, for example:

- When did your company implement an SF program?
- What prompted your company to start an SF program?
- Based on your company's experience, does an SF program prevent soft-tissue injuries?
- Based on your company's experience, does an SF program reduce 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 firms. Following are several example questions:

- What are the most frequent types of injury or illness in your line of work?
- What is the most severe (dollar cost) injury or illness in your line of work?
- How do these injuries or illnesses typically happen?
- Rank these parts of the body as to the frequency at which injuries and illnesses occur.
- When are your employees most likely to get injured upon employment at your company?

The fourth section solicited information on the participant firms' safety performance 3 years before and after SF program implementation. For the purposes of the study, safety performance was measured using the WMSD rate (WR), OSHA-recordable incident rate (TRIR) and lost-time case incident rate (LTCR) before and after SF program implementation.

WMSDs include all injuries of the muscles, tendons, joints and nerves caused or aggravated by work. These can include carpal tunnel syndrome, tendinitis, rotator cuff injuries (shoulder problems), epicondylitis (an elbow problem), sprains/strains and back injuries. WR is calculated as the number of WMSDs per 100 full-time workers per year (200,000 work hours). OSHA-recordable incidents are defined as those that result from an exposure or event in the workplace, and that require some type of medical treatment beyond first aid. LTCR incidents are those incidents that result from an exposure or event in the workplace, and that require the employee to be away from work. Both TRIR and LTCR are calculated in a manner similar to WR.

The participants targeted for the research were primarily construction firms in the western U.S. who also perform work in other parts of the country. Selection criteria was construction firms that have implemented a mandatory SF program within the past 10 years. No database exists that identifies construction firms with mandatory SF programs. Therefore, participants were selected based on convenience: 13 firms with which the authors have personal contact and were willing to participate in the research. Literature suggests that the use of a purposeful sample is considered ideal for enhancing validity when a large sample size is unrealistic (Patton, 1990, as cited in Hallowell, 2010).

The 13 construction firms employed crafts in 16 different specialties (e.g., carpenters, electricians, operators, sheet metal workers, laborers, plumbers/pipefitters, cement masons, finishers, truck drivers, demolition, landscapers, mason, pile bucks/pile drivers, millwrights). The firms' annual revenues ranged from $95 million to $6 billion. The types of project delivery methods typically used by the companies were design-build, design-bid-build, construction manager at risk (CM at risk), hard bid, guaranteed maximum price and design assist. Most participants were union shops. Number of employees ranged from 75 to 2,000. Construction specializations were highways/bridges/

roads, education/school, government, commercial, healthcare, concrete structures and heavy civil.

The authors sent the online questionnaires via e-mail to safety professionals working for these firms. The authors requested that they respond to the questions based on their firms' experience with SF program implementation. Data collection took place from May 2015 to December 2015. The Human Subjects Review Committee affiliated with author Rajendran's institution (Central Washington University) reviewed and approved the study. The purpose of the study was to gather information about the respondent firms' SF programs and injuries. Because OSH professionals are typically responsible for overseeing the development and implementation of SF programs, OSH professionals were selected as the respondents.

Statistical analysis for descriptive statistics and t-tests of the data were conducted using SAS 9.3 analytics software. The authors computed the incidence rates of injuries (rates per 100 full-time workers) in a given year from the following: Incident rate was calculated by multiplying the number of injuries by 200,000, then dividing that number by the number of labor hours at the company.

FIGURE 1
Injury Type

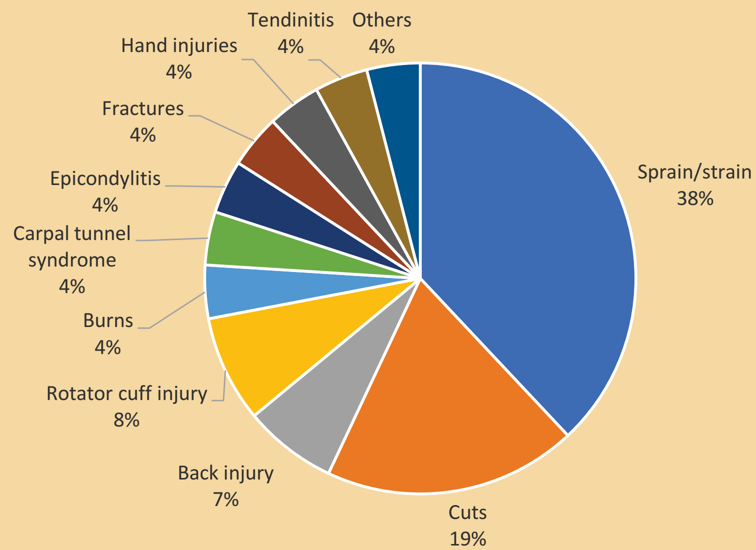
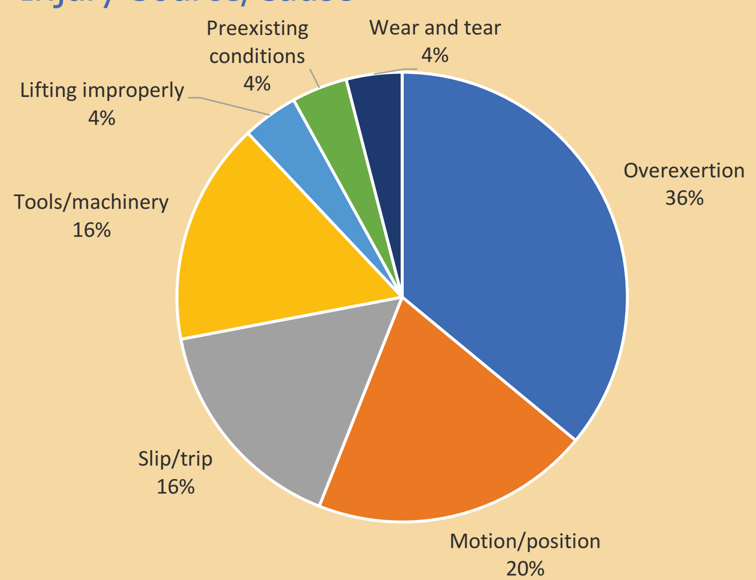


FIGURE 2
Injury Source/Cause



SF Program & Safety Performance

SF Program Information

All responding companies had written safety and health, and SF programs. Based on respondents' experience with SF programs, 62% (8 of 13) reported that SF programs reduced the severity of WMSD injuries, and 38% (5 of 13) were unsure. Furthermore, 46% (6 of 13) reported that SF prevented WMSD injuries, while 54% (7 of 13) reported *no* or *unsure*.

Table 1 describes companies' involvement with SF programs (i.e., what prompted them to start an SF program, how they created or developed the program, and how workers are trained on the program). About two-thirds of the companies trained all workers on SF programs and about one-third had a warm-up requirement before starting to perform SF exercises. The warm-up sessions were reported to take less than 10 minutes. Workers performed the SF exercises mostly before or at the beginning of a shift/task, or in the morning of a typical day.

About 54% (7 of 13) of the companies had SF exercises tailored to their job duties/trades. About 62% (8 of 13) of respondents reported that the exercise period was adequate (e.g., 10 to 15 minutes per session). About 85% (11 of 13) of respondents reported that the foreman or supervisor led the SF exercises. About 69% (9 of 13) of respondents reported that the leaders were trained in SF. Most of the companies (85%, 11 of 13) monitored program compliance.

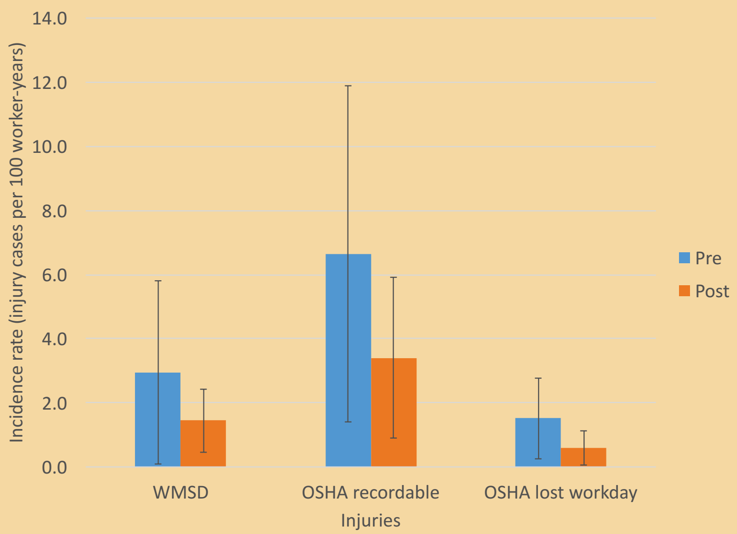
Injury & Illness Information

Sprain/strain was the most frequent injury type followed by cuts, rotator cuff injury, back injury, tendinitis, epicondylitis and carpal tunnel syndrome (Figure 1). Back injury, sprain/strain, rotator cuff injury and carpal tunnel syndrome were frequently reported as the most severe (in terms of dollar cost) injury or illness. The sources/causes of these injuries or illnesses were typically overexertion, motion/position, slip/trip, tools/machinery, lifting improperly and wear/tear-degenerative (Figure 2).

Companies reported injuries and illnesses most frequently occurred to the following body parts (ranked by frequency, most to least): 1) hands/fingers; 2) back; 3) (tie) shoulders; foot/ankle; 5) eyes; 6) knees; and 7) head/neck. Companies reported injuries most likely occurred to workers after they

FIGURE 3

Safety Performance Before & After SF Program Implementation



had been employed for (ranked by frequency, most to least): 1) < 3 months; 2) 3 to 11 months; 3) > 5 years; and 4) 1 to 5 years.

SF Program Implementation

The authors collected and analyzed the information on pre- versus post-SF program implementation and safety performance (i.e., years, total worker hours, number of WMSD injuries, number of OSHA-recordable injuries, number of OSHA lost-workday injuries). They calculated incidence rates of injuries, respectively. Normalized injury rates were the average rates 1 to 3 years before and after the baseline (the year the SF program was implemented).

Significant differences existed in all three average injury rates (i.e., WMSD injuries, OSHA-recordable injuries, OSHA lost-workday injuries) before and after implementation of SF programs. The researchers conducted a paired-samples t-test to compare normalized average injury rates in 1 to 3 years before and after the baseline conditions.

•The average number of WMSD injuries between these two periods dropped 51.2%. This difference was statistically significant: WMSD injuries for 1 to 3 years before the baseline (Mean = 2.9486, SD = 2.8570) versus those of 1 to 3 years after the baseline (Mean = 1.4403, SD = 0.9834); ($t(11)$ = 2.42, p = 0.0339).

•The average number of OSHA-recordable injuries between these two periods decreased 48.7%. This difference was also statistically significant: OSHA-recordable injuries for 1 to 3 years before the baseline (Mean = 6.6467, SD = 5.2420) versus those of 1 to 3 years after the baseline (Mean = 3.4079, SD = 2.5071); ($t(11)$ = 2.460, p = 0.0246).

•In OSHA lost-workday injuries, the average number dropped 60.8%, the highest of the three, and the difference was statistically significant: OSHA lost-workday injuries for 1 to 3 years before the baseline (Mean = 1.5107, SD = 1.2580) versus those of 1 to 3 years after the baseline (Mean = 0.5922, SD = 0.5332); ($t(11)$ = 2.97, p = 0.0127).

Figure 3 depicts the participating firms' safety performance 3 years before and after SF program implementation. The error bars represent incidents rates ± 1 standard deviations.

These results suggest that SF programs affect safety performance (injury rates before and after SF program implementation). Specifically, the authors' findings reveal that when SF programs are implemented, the rates of WMSD injuries potentially can be decreased. Following are survey respondents' comments on how SF programs affected safety performance.

•A morning stretch and flex has helped us reduce the number of strain/sprain injuries since implementation. In addition, it allows project leadership an opportunity to look at all our craft each morning before they go to work to ensure that they are fit for duty.

•Cannot hurt, employees like it, it's been a positive.

•Difficult to correlate safety improvement to SF program due to numerous changes and improvements to safety program since 2009. Employees generally seem to enjoy SF activities and willingly participate.

•Side effects of stretching and flex program: Improved communication, team work, resource sharing, problem solving. We love it as a company.

•The stretch and flex program has greatly improved the WMSD-related injuries since we implemented the program. We are very happy with the results.

•We have always had an SF program since 2001 when the company started.

•We have had mixed reviews and recently transitioned from an SF to a warm-up program. Still too early to have data, but we've had zero recordables 2015 year to date.

Discussion & Conclusion

This study aimed to evaluate the impact of an SF program on construction worker safety and health by comparing the difference in construction firms' WMSDs and injury rates associated with the implementation of such a program. This study analyzed information on participants' SF programs, injuries/illnesses and pre- versus post-SF program implementation/safety performance (i.e., numbers of WMSD injuries, OSHA-recordable and lost-workdays injuries). The safety performance/incidence rates from pre- versus post-SF program implementation revealed that WMSDs and injuries can be reduced by implementing SF programs.

The findings from this limited study revealed that SF programs had significant effects on safety performance of the participating firms. Particularly, respondents noted that WMSD rates were lower when SF programs were implemented. Moreover, participants reported positive comments and perceptions on the effects that SF programs had on safety performance.

A previous study by Choi and Rajendran (2014) identified perceptions of construction workers who performed SF daily about the effectiveness of SF programs in preventing WMSDs. That study found that most workers perceived that the SF program helped prevent WMSDs. In addition, workers perceived other SF program benefits, such as increased alertness and focus, communication, team building, improved flexibility and safety planning (Choi & Rajendran, 2014).

The authors believe the reason SF programs have never truly taken hold industry-wide is a complex subject. While avoiding speculation, the authors believe the primary reason may be lack of empirical research reporting the benefits of SF programs in preventing WMSDs. Furthermore, contractors may be reluctant to invest in a program that requires significant resources without knowing the true return on investment. Construction is a relatively low-profit industry with extremely low markup within certain specialties. Therefore, just as with any new safety program in the construction industry, the cost factor could be prohibitive.

In the current study, SF exercise leaders were superintendent, foreman/supervisor or a different person daily, with most leaders trained in SF. WMSDs and injuries such as sprain/strain and back injury due to overexertion and motion/position were most frequently reported. It is interesting to note that significant differences existed in all three injury rates (number of WMSD injuries, number of OSHA-recordable injuries, number of OSHA lost-workday injuries) before and after implementation of SF programs. The literature suggests that construction contractors/firms should consider investing in comprehensive ergonomic interventions such as engineering and administrative controls to mitigate WMSD risks.

The authors did not use any other controls to address confounding factors or other contributing factors. They used a paired-samples t-test to compare normalized average injury rates in 1 to 3 years before and after the baseline conditions (the year an SF program was implemented). By using the paired sample t-test, we can statistically conclude whether SF programs affect safety performance (injury rates before and after SF program implementation). Because the before and after samples measure the same subjects, the paired t-test can reduce the effects of confounder and is considered as the most appropriate analysis. The paired observations are dependent on each other. Therefore, a paired t-test is not subject to additional variation occurring from the independence of the observations.

Despite some limitations (e.g., small sample size, uncontrolled group, one region of the country), the study systematically presents the positive effects of implementing SF programs on safety performance (e.g., WMSDs and injury reductions). All in all, these findings can provide valuable insight on SF program implementation to alleviate WMSDs and injuries in the construction industry. **PS**

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