Do Stretching Programs Prevent Work-related Musculoskeletal Disorders?

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Abstract

In the United States, the most common types of non-fatal occupational injuries that result in days away from work are musculoskeletal injuries such as sprains and strains (Bureau of Labor Statistics, 2008). Work-related musculoskeletal disorders (WMSDs) occur in all types of industries varying from heavy manufacturing, light assembly, health care, construction, and office environments. There is a growing interest in, and use of, stretching and flexibility exercises to reduce the risk of work-related musculoskeletal disorders. The purpose of this study is to review the recent research literature on industry-specific workplace stretching programs and their effects on reducing work-related musculoskeletal disorders and injuries. This study indicates that some occupations employed workplace stretching exercise programs reported benefits including reductions of pains/disability and costs of WMSDs, as well as improvements of flexibility/range of motion and subjective satisfaction scores. Despite the positive inclination towards the benefits of stretching, it is still contentious to reach a definite response about the effectiveness of stretching to prevent work-related musculoskeletal disorders and injuries. Recommendation for WMSD injury prevention and future SH&E study is discussed in the paper.

INTRODUCTION

Musculoskeletal disorders are injuries affecting the connective tissues of the body such as muscles, nerves, tendons, joints, cartilage, or spinal discs (Bureau of Labor Statistics, 2008). Musculoskeletal disorders may occur when muscles or tendons are stretched or over-used beyond their capabilities. The ergonomic risk factors that can cause or aggravate musculoskeletal disorders include: repetitive motion, awkward posture, forceful exertions, pressure points, and static postures (NIOSH, 2007). The Bureau of Labor Statistics (2005a) reported that sprains and strains accounted for the highest frequency of all occupational injuries in the United States. While work-related musculoskeletal disorders occur in all types of industries, the service providing industries reported the most musculoskeletal disorders, accounting for 69 percent of all cases (BLS, 2005a). Within these industries, health care and social assistance reported the most cases. The three occupations with the most musculoskeletal disorders were laborers and material movers; nursing aides, orderlies, and attendants; and heavy/tractor-trailer truck drivers. U.S. Nursing aides, orderlies, and attendants had a musculoskeletal injury rate of 252 cases per 10,000 workers, a rate more than seven times the national WMSD average for all occupations (Bureau of Labor Statistics, 2005b).

Methods used to reduce or eliminate the ergonomic risk factors include engineering and administrative controls (NIOSH, 2007). Engineering controls typically involve redesigning a workstation or a process to reduce the ergonomic risk factors. Administrative controls involve rotating workers through a particular workstation to effectively reduce the exposure to an ergonomic risk factor. While many companies recognize implementing engineering controls is the ideal method of reducing ergonomic risk factors, significant capital expenditures and complicated workstation and process redesign are often required. Additionally, it can be difficult

for ergonomic investment proposals to compete with other investment alternatives (Brace and Veltri, 2009). Administrative controls such as job rotation do not require high capital expenditures; however, they can become complicated due to job specific training requirements and physical capability requirements for a specific job task.

Another method employers use to reduce the occurrence of work-related musculoskeletal disorders and injuries is stretching and flexibility exercise programs (Drennan et al., 2006). Stretching is a form of physical exercise in which a specific skeletal muscle is deliberately elongated to its fullest length in order to improve the muscle's felt elasticity. Benefits of stretching may include increased flexibility, improved range of motion within joints, improved circulation improved posture, and stress relief. It is commonly believed that stretching before or after physical activity can reduce the chance of a strain or sprain injury by increasing the flexibility of muscles, tendons and ligaments, which in turn increases the range of motion in a joint or group of joints. Advocates of workplace stretching programs claim that these programs have reduced and prevented sprain and strain injuries. While these reports are frequently published in trade journals, they are typically based on uncontrolled and quasi-experimental in-house evaluations that rely on self-reported outcomes rather than objective measures (Hess and Hecker, 2003).

There is a growing interest in, and use of, stretching/flexibility exercises to reduce the risks of work-related musculoskeletal disorders and injuries at the workplace. To date, very little is known about the industry-specific outcomes of stretching programs. The aim of this review study is to synthesize the recent literature on workplace stretching exercise programs and their effects on reducing WMSDs in different occupational groups.

METHOD

To classify research studies on work related stretching programs, specific keywords were identified and used in a systematic search to guide the discovery of relevant studies and data. Electronic databases including ELCOSH, PubMed, ScienceDirect, ASSE Professional Safety Article Archive, and Google Scholar, were searched for the following keywords and combinations of these words: workplace, stretching, exercises, injury, work, prevention, safety, occupation, and ergonomics. Printed materials including industry magazines and professional journals were also searched. Internet sites including the Bureau of Labor Statistics (BLS), the Occupational, Health and Safety Administration (OSHA), and the National Institute for Occupational Safety and Health (NIOSH) was also searched.

WHAT IS A STRETCHING?

Stretching is the act of performing a particular exercise to improve joint range of motion, while flexibility is traditionally considered the joint range of motion that can be measured (Magnusson and Renstrom, 2006). There are three common types of stretches; proprioceptive neuromuscular facilitation (PNF), static and isometric. Proprioceptive neuromuscular facilitation stretching combines static and isometric stretching techniques. Most advocates of stretching programs recommend PNF stretching (Sharman et al, 2006). PNF stretching allows the muscle to be stretched to a greater degree by increasing the proprioceptor signals through a 5- to 10-second voluntary muscle contraction followed by a 5- to 10-second voluntary muscle relaxation. With the hold-relax PNF method, the muscle is placed into a static stretch. The person is instructed to "hold" and contract the muscle against resistance from a partner for 10 seconds. The person is then instructed to "relax", and the partner slowly moves the muscle to a new static position. The

technique is repeated two to three times. If inadequately performed, stretches may also cause or aggravate injuries (Costa and Vieira, 2008).

WORKPLACE STRETCHING PROGRAMS

Studies on industry based stretching programs to mitigate work-related musculoskeletal disorders (WMSDs) are discussed in the following: stretches in computer work, manufacturing work, heavy work, and construction work.

Stretching at Computer Work

Jepsen and Thomsen (2008) examined the effects of stretching on the prevention of upper limb disorders in the right arm among computer operators. They conducted a controlled study of 184 computer operators, within two different divisions, that spend their workday at computer workstations. All participants spent at least 20% of their time at computer workstations. To establish a baseline, all of the subjects completed a questionnaire and a neurological examination. The stretching intervention consisted of a physiotherapist instructing stretching exercises based on neurodynamic principles. The physiotherapist prescribed four different stretches for the intervention subjects. Each of the four stretches focused on a different region of the right arm; the volar forearm flexors, the pronator muscle, the median nerve and the radial nerve. The control group did not engage in any stretches. The experiment lasted for six consecutive months. At the conclusion of the experiment, all of the subjects participated in a follow up neurological examination and a questionnaire. The outcome data consisted of self-reported pain levels and neurological findings. The researchers found a significant improvement with regard to the function of the pronator muscle. Mechanosensativity was significantly

improved for the median nerve. They concluded that stretching alone could not be identified as a single method of preventing upper extremity disorders among people who work at computer workstations (Jepsen and Thomsen, 2008). A joint study conducted by researchers at the National Institute of Occupational Safety and Health (NIOSH) and the Internal Revenue Service (IRS) examined the effects of rest breaks and stretching exercises on symptoms and performance of data-entry workers. The participants were randomly divided into two groups. One group was instructed to perform brief stretching exercises during breaks. The other group, the control group, did not perform stretching. At the end of the study, workers completed the study symptom questionnaires. In the group that performed the stretching, workers reported stretching during only 25% of the conventional breaks and 39% of supplementary breaks, and no significant effects of stretching on discomfort or performance were realized. The authors concluded that because the study participants had a low compliance in performing stretches, the effects of the assessment could not be determined. Also, they supported that further research on stretching exercises and exercise compliance is warranted (Galinsky et al., 2007).

Stretching at Manufacturing Work

A research study was conducted at a pharmaceutical manufacturing facility which examined the effect of a workplace stretching program (Moore, 1998). The study consisted of 36 stretching sessions over a 2-month period and involved 60 employees. Flexibility was measured by a flexibility profile including the sit and reach test, bilateral body rotation measurements, and shoulder rotation measurements. During the study, each participant performed stretching 5 times per day. Each session lasted between 5 and 8 minutes. The stretching exercises involved the neck, shoulder, arm, trunk, hip, back and legs. Upon completion, research participants reported

an increase in flexibility and an increase in physical self perceptions (i.e., body attractiveness, physical conditioning, and overall self worth). During the stretching program period, the participants did not report any work-related musculoskeletal injuries. The findings indicated that stretching programs in the workplace may benefit employees by increasing flexibility and potentially preventing WMSDs (Moore, 1998). However, this study showed limited description of stretching protocol and included no control groups.

Stretching at Heavy Work

Herbert and de Noronha (2007) used meta-analysis to pool the results of comparable studies. The research consisted of five studies that investigated the effects of stretching on delayed onset of muscle soreness. A total of 77 subjects participated in the study (27 were allocated to the stretching groups, 20 subjects were allocated to control groups, and 30 were allocated to both stretch and control groups). The stretch times for participants varied between 300 seconds and 600 seconds (5 to 10 minutes respectively). The research results indicated that stretching before and after exercising reduced muscle soreness at the 72-hour interval less than 2 mm on a scale of 100 mm. The authors felt that because this was so insignificant, most athletes would not use stretching to prevent muscle soreness (Herbert and de Norohna, 2007). Herbert and de Noronha then reviewed two studies that evaluated the effectiveness of stretching on the risk of injury in new military recruits. The first study examined the effect of stretching calf muscles and the risk of injury to six specific leg injuries; lesions to the Achilles tendon, lateral ankle sprains, stress fractures to the foot and tibia, periostitis, and anterior tibial compartment syndrome. The second study examined the effect of stretching six muscle groups in the lower limbs (legs) on the risk of any injuries to the lower legs. The participants, military recruits, were

defined as injury free if they were able to return to full duty without symptom on the following day. These two studies yielded similar estimates of risk reduction. A total of 2630 subjects participated in the two studies. The authors reported there was a discrepancy in the subject sample size because military personnel allocated subjects to different platoons during the experiment. A total of 181 injuries occurred in the two stretching groups and 200 injuries occurred in the control group. The two studies revealed that stretching only decreased the risk of injury by 5%, which is not significant. The authors concluded that stretching before exercise does not prevent post-exercise muscle soreness. They also found little support for the theory that stretching immediately before exercise can prevent either overuse or acute sports injuries. A study of 469 municipal firefighters evaluated the effectiveness of a flexibility program on work related injuries (Hilyer et al., 1990). Specifically, researchers examined the incidence, cost and severity of joint injuries between groups of firefighters that stretched and groups that did not stretch. The stretching exercise program consisted of one daily 30-minute session during a 6 month period. Each stretching session included twelve different exercises. The firefighters that did participate in the stretching program were more flexible than those who did not participate. Over the course of two years, the group of firefighters that participated in stretching incurred 48 injuries and the non-stretching group experienced 52 injuries. The injury types were not described. The cost of the injuries was significantly different between the two groups. The total cost of injuries (medical and indemnity) for the group of firefighters that stretched was $85,371, while the cost of injuries for the group of non-stretchers was $235,131. This suggests that injuries sustained by the firefighters that participated in the workplace stretching program were less expensive than injuries sustained by non-stretchers (Hilyer et al., 1990).

Stretching at Construction Work

Holmstrom and Ahlborg (2005) evaluated the effects on muscle stretchability, joint flexibility, muscle strength and endurance in construction workers of a 3-month period of a 10-min morning warming-up exercise, performed at the building site every working day. They conducted a controlled study of 47 male construction workers from two different building sites. The intervention program was composed by physiotherapists and conducted by a trained worker at the site. The exercise activities included different arm-swings combined with knee-bendings, shoulder lifts, leg kicks, spinal movements, transfer of body weight from side to side and jogging mark time. Each morning warming-up exercise session was ended with stretching, particularly of the hamstring, quadriceps, and calf muscles. After a period of morning warming-up exercises hamstring and thigh muscle stretchability as well as thoracic and lower back flexion mobility increased. A significant difference in back muscle endurance but muscular strength was not affected. The authors suggested that a short dose of morning warming-up could be beneficial for increasing or maintaining joint and muscle flexibility and back muscle endurance for workers exposed to manual material handling and strenuous working positions (Holmstrom and Ahlborg, 2005). Ludewig and Borstad (2003) evaluated a therapeutic exercise program intended to reduce pain and improve shoulder function. Sixty-seven male construction workers volunteered to this controlled study. Subjects in the intervention group were instructed in a standardized 8 week home exercise program of five shoulder stretching and strengthening exercises. The intervention group showed significantly greater improvements in the Shoulder Rating Questionnaire score and shoulder satisfaction score than the control groups. Moreover, pain and disability were significantly lower in the intervention group. The authors suggested that a home exercise

program can be effective in reducing symptoms and improving function in construction workers with shoulder pain with routine exposure to overhead work (Ludewig and Borstad, 2003).

[Insert Table 1 about here]

DISCUSSION

While majority of the literature reviewed in this study may not fully explain that stretching at work will prevent work-related musculoskeletal injuries, some studies have shown that performing stretching exercises can contribute to reducing discomfort/pain and increasing range of motion (ROM). Particularly, construction workers participated in stretching & exercise programs reported significant positive effects including reductions in pains/disability, increases of muscle flexibility and endurance, as well as improvements of subjective shoulder satisfaction scores (Holmstrom and Ahlborg, 2004; Ludewig and Borstad, 2003). As pointed by Moore (2002), workplace stretching exercise programs may also increase an employee's perception of his/her own body attractiveness and overall self-worth.

It is important to mention here that work-related MSD prevention interventions should also focus on the reduction or elimination of the job task-specific ergonomic risk factors. This can be accomplished with a comprehensive ergonomic program which includes a combination of engineering and administrative controls, training, management and employee support and sufficient resources (Amick et al., 2009). Scientific evidence does show that effective ergonomic solutions can lower the physical demands of manual material handling work tasks; thereby lowering the incidence and severity of the musculoskeletal injuries they can cause (NIOSH, 2007). Companies that have implemented OSHA's ergonomic guidelines have lower incidence

cumulative trauma injuries and associated workers' compensation costs (May, 2002). Engineering controls include material handling devices and workstation design. Examples of material handling devices, such as carts used to transport heavy objects, jib hoists for lifting to lift heavy objects, vertical carousels to store parts, and automatically adjustable pallet tables can reduce the ergonomic risk factors. Workstations should be designed with the idea that the human body is stronger, more efficient, and less prone to injury when work is performed in midrange postures. Ideally, workstations should be adjustable to properly accommodate all workers. Administrative controls include job rotation, job enlargement, and intermittent breaks. The purpose of the administrative controls is to reduce the frequency and duration of physically demanding activities by altering the tasks performed by employees. To be effective, job rotation and job enlargement should include changing the jobs and tasks that differ in muscles used, working postures, and pace of work, amount of repetition, and amount of physical exertion required, visual and mental demands, and environmental conditions (NIOSH, 2007; 2006).

Future research should examine variables including the age of the workers, anatomical characteristics that could predispose a worker to musculoskeletal disorders, and the content and duration of the stretching program (Hess, 2002). SH&E educators and researchers should also identify the non-work related activities of participants that could contribute to injuries of concern, such as high impact sports. Furthermore, the research should closely track the specific jobs of the tasks that each participant performs throughout the study. Alternating jobs throughout the course of the study could introduce unknown variables and reduce the validity of the data. Future studies are also warranted to investigate different stretching/exercise protocols, types of stretching (static or proprioceptive neuromuscular facilitation), frequency, intensity, duration,

and time of stretch/exercise so that more efficient protocols can be developed and implemented (Costa and Vieira, 2008).

CONCLUSIONS

This review study explored recent research literature on workplace stretching exercise programs and their effects on reducing WMSDs in different occupational groups. While research does support that stretching improves flexibility/ROM and self worth, stretching alone might not prevent work-related musculoskeletal disorders and injuries. Some studies (e.g., Thacker, 2004) also suggested that strength training, conditioning and warm-up could play an important role in preventing WMSDs. Note that work-related MSDs are costly to business and also cause employee operating errors that result in substandard work quality and reduced operational productivity (Graves, et al., 2004). As pointed by OSHA (1993), implementing a comprehensive ergonomic program that includes both engineering and administrative controls to reduce the ergonomic risk factors should be the first choice in reducing work-related MSDs. The main focus of a comprehensive ergonomic program is to make tasks, jobs, products, environments and systems compatible with the needs, abilities and limitations of people, as opposed to making the people compatible with the work characteristics and demands (in Costa and Vieira, 2008). Overall, this review study illustrates some favorable outcomes of stretching & exercise programs in different occupations, but there is still controversial to accomplish a definite response about the exploit of stretching in preventing work-related musculoskeletal disorders and injuries.

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TABLE

Table 1. Summary of the effects of stretching exercises on WMSDs in different occupations

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Associated activity	Author(s), year	Stretching protocol	Study objective	Main findings
Computer work (computer operators)	Jepsen and Thomsen, 2008	Upper limb stretching course at least 3 times during workdays in a six month period	Determine the efficacy of stretching on upper limb pain	While stretching seemed to reduce upper limb pain, stretching alone could not be identified as the single method of preventing upper extremity MSD
Computer work (data entry)	Galinsky et al., 2007	4 weeks (two 15 min breaks/day); 4 weeks with supplementary breaks (two 15 min breaks plus four 5 min breaks/day)	Examine the effects of rest breaks and stretching exercises on symptoms and performance in data-entry workers	Participants had low compliance in performing stretches which prevented valid assessment of stretching effects
Manufacturing (pharmaceutical)	Moore, 1998	Stretching sessions were held 5 times a day and lasted 5-8 min	Examine the effects of a workplace stretching program	Participants reported improved flexibility and self worth; however research did not include a control group
Heavy work (athletic and military activities)	Herbert and de Noronha, 2007	Stretching soon before or soon after exercise	Determine effects of stretching on post-exercise muscle soreness and injury prevention	Stretching did not significantly reduce delayed-onset muscle soreness or prevent injuries (in young healthy adults)
Heavy work (municipal firefighters)	Hilyer et al., 1990	The stretching exercise program consisted of a 30-min session held approximately 3 times a week during a period of 6 months	Evaluate the effect of flexibility stretching on frequency and severity of joint injuries	The flexibility exercise program did not reduce the frequency of injuries; however the program did reduce the severity & costs of MSD
Construction work	Holmstrom and Ahlborg, 2005	A 10-min exercise every morning (paid working time at the building site) during a period of 3 months	Evaluate the effects on muscle stretchability, joint flexibility, muscle strength and endurance in construction workers	Increase of thoracic/ lower back mobility, hamstring/thigh muscle stretchability, back muscle endurance; however muscular strength was not influenced by the morning warming-up exercise
Construction work	Ludewig and Borstad, 2003	A standardized 8 week home exercise program of five shoulder stretching and strengthening exercise (two stretches for 30s/repetition)	Evaluate a therapeutic exercise program intended to reduce pain and improve shoulder function	Significantly reductions in pain and disability, and improvements in the Shoulder Rating Questionnaire score and shoulder satisfaction score