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ABSTRACT

EFFECTS OF ONSITE STRETCHING EXERCISE ON EMPLOYEE MUSCULOSKELETAL DISCOMFORT AND WELLBEING

by
Kellie L. Caldwell

To fight high incidence of musculoskeletal pain and discomfort complaints among the maintenance workers in a large transportation company, this pilot intervention study of an on-site stretch and flex exercise program was implemented. The participants (n=62) were maintenance workers; whose age ranged from 26 to 69 years.

A 4½-minute video was created which included still images of human figures performing stretches, while a voice recording instructed how to perform each stretch. Exercises targeted the neck, shoulders, triceps, hamstrings, and quadriceps. The exercise program was conducted 5 days a week for 5 consecutive weeks, during daily shift meetings.

The results of the intervention revealed that average discomfort levels reduced significantly ($p<0.1$) in neck (1.4 down to 0.76), in upper extremity (1.4 down to 0.79), in lower extremity (2.2 down to 1.29), and while performing activities of daily living in terms of personal care (0.3 down to 0.05), and lifting (0.52 down to 0.22) activities. Employee attitude towards performing stretch flex exercise at work had also improved after participating for 5 weeks. The study results strongly suggest that an on-site stretch and flex exercise program is an effective means of relieving pain and discomforts from manual work, and perceived to be beneficial by the workers.

EFFECTS OF ONSITE STRETCHING EXERCISE ON EMPLOYEE MUSCULOSKELETAL DISCOMFORT AND WELLBEING

by
Kellie L. Caldwell

A Thesis
Submitted to the Faculty of
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APPROVAL PAGE

EFFECTS OF ONSITE STRETCHING EXERCISE ON EMPLOYEE MUSCULOSKELETAL DISCOMFORT AND WELLBEING

Kellie L. Caldwell

Dr. Arijit Sengupta Date
Associate Professor, Department of Mechanical and Industrial Engineering

---

Dr. Athanassios Bladikas Date
Associate Professor, Department of Mechanical and Industrial Engineering

---

Dr. George Olsen Date
Adjunct Professor, Department of Mechanical and Industrial Engineering

BIOGRAPHICAL SKETCH

Author: Kellie L. Caldwell

Degree: Master of Science

Date: May 2015

Undergraduate and Graduate Education:

- Master of Science in Occupational Safety and Health Engineering,
  New Jersey Institute of Technology, Newark, NJ, 2015

- Bachelor of Science in Exercise Science
  Indiana University of Pennsylvania, Indiana, PA, 2010

Major: Occupational Safety and Health Engineering

I dedicate this thesis to my mother and father, Della and David Caldwell, in recognition of their overwhelming support, powerful inspiration, and unconditional love.

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CHAPTER 1

INTRODUCTION

Musculoskeletal Disorder (MDS) has become a common type of injury in the workplace throughout the world. It may occur when muscles or tendons are stretched or over-used beyond their capabilities (Choi and Rajendran, 2014). Physically demanding nature of work, and/or repetitive tasks may increase worker exposure to strains and sprains. MSD's are injuries or dysfunctions affecting muscles, bones, nerves, tendons, ligaments, joints, cartilages and spinal discs. In the U.S. alone, more than 600,000 workers have MSD resulting in days away from work each year (Costa and Vieira, 2008). This creates a tremendous effect on not only individual employee in terms of pain and suffering, but also on company/corporation productivity. Activity demands can cause or aggravate MSD (da Costa and Vieira, 2008). Low back pain (LBP) is the most common occupational MSD injury. In addition to medical expenses, MSD may adversely influence the quality of life and work performance of employed individuals.

Health and wellbeing have important consequences for individual employees, as well as for the organization in which they work (Danna & Griffin, 1999). Some areas of concern for the employer include productivity/job performance, absenteeism rates, injury rates, illness, workplace morale/enthusiasm, etc. Gains in employee health and wellbeing can go beyond financial profits since they can be perceived as a sign that their company values the employees. Health promotion programs may therefore work to improve the

image of a company as an organization that cares about the welfare of its employees, and this may attract productive employees. Workplaces that offer exercise programs have steadily increased in the US, and research suggests that employees 'feel better' as a result of exercise participation (Shepard, 1996). Workplace physical activity programs have been shown to be successful in improving health and productivity outcomes (Pronk, 2009). In the last decade, more focus has been on the workplace as a convenient setting for health promoting initiatives (Danna & Griffin, 1999). Workplaces can implement physical programs for keeping workers healthy and reducing healthcare costs. Since employed adults spend about half of their workday waking hours at workplaces, offering physical activity programs at work may be an efficient strategy to increase muscle flexibility.

1.1 Physical Activity Benefits

It is well known that physical activity offers endless health and wellness benefits. Physically active adult men and women have lower rates of all-cause mortality, coronary heart disease, stroke, type 2 diabetes, colon cancer, breast cancer, depression, high blood pressure, and metabolic syndrome. In addition, physically active adults also have a body mass, body composition, and a biomarker profile that resist the development of cardiovascular disease and type 2 diabetes (Pronk, 2009). There is evidence that sleep quality and overall health-related quality of life are higher among physically active adults as well (Pronk, 2009). Both specific muscle training and all-around physical exercise have shown beneficial effects on neck pain as well as low back pain (Hayden et al., 2005; Ylinen, 2007).

Well-being is defined as the state of being comfortable, healthy, happy, or successful. Therefore, different elements make up well-being. Various aspects may include discomforts related to activities of daily living such as personal care, headaches, recreation, concentration, and sleeping. Consistent positive effects of exercise on several positive well-being variables have been documented (Thogersen-Ntoumani et al. 2005).

When examining the psychological effects of exercise, in multiple studies, exercise was associated with a reduction in the symptoms of depression (Craft, 2005). This is attributed to the positive effects that exercise has on mood, anxiety, self-perceptions, and self-esteem. Furthermore, randomized controlled trials have indicated that improvements in physical self-perceptions through exercise can generalize to global self-esteem (Thogersen-Ntoumani et al. 2005). It is an intuitive thought, that self-esteem is linked to job performance because employees with positive views of themselves are more motivated to perform well in their jobs.

1.2. Types of Exercise

Exercise is a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness (Caspersen and Powell et al. 1985). The American College of Sports Medicine (ACSM) categorizes exercise types into four groups; resistance exercise, cardiorespiratory exercise, stretching or flexibility exercise, and neuromotor exercise.

1.2.1 Resistance Exercise

Resistance exercises can enhance muscle performance and force production (Kietrys, 2007). In one study, strong evidence was found for the effectiveness of muscle

strengthening and endurance exercises in treating neck pain. Muscle endurance is the ability of a muscle group to exert a certain amount of force repeatedly whereas muscle strength is the ability to exert a maximum amount of force against resistance. Evidence has supported the use of muscle endurance exercise in reducing disability attributed to neck pain (Sihawong, 2011).

1.2.2 Cardio Exercise

The ACSM recommends adults should get at least 150 minutes of moderate-intensity cardio exercise per week, and that gradual progression of exercise time, frequency and intensity is recommended for best adherence and least injury risk ("ACSM Issues New Recommendations," 2015). Although cardio exercise is highly recommended and popular outside of the workplace, very few studies have been done in the workplace involving cardio exercise.

1.2.3 Stretching Exercise

Stretching is a form of physical exercise that entails a specific tendon, muscles, or group of muscles flexing in order to improve the muscle's felt elasticity and achieve comfortable feeling in the muscles during resting state. The result of stretching is a feeling of increased muscle control and flexibility/range of motion. Stretching is also used therapeutically to alleviate cramps. Increasing flexibility through stretching is one of the basic principles of physical fitness. It is common for athletes to stretch before and after exercise in order to reduce injury and increase performance. Stretching is advocated for the prevention of injuries associated with work or athletic performance (Kietrys, 2007). Stretching is also often encouraged for treatment of musculoskeletal pain/discomfort. After any physical activity, the physiological response in the body is a

buildup of lactic acid. By stretching, an individual is helping the body to release lactic acid, therefore alleviating muscle pain and/or cramps. This treatment and prevention is through promotion of flexibility and extensibility of joints and muscle tendon units (Kietrys, 2007). Previous experiments involving stretch and flex (SF) programs have identified several benefits perceived by workers/participants involved. Some responses were grouped into categories such as mental preparation (helping employees wake up in the morning, keeping participants alert and focused), physical preparation (increasing flexibility, feeling limber and loose), communication and team building, safety planning, general physical health, and preventing muscle injuries (Choi and Rajendran, 2014).

1.2.4 Neuromotor Exercise

Neuromotor exercise (sometimes called “functional fitness training”) is recommended for 2 or 3 days per week, for 20-30 minutes per day. Exercises should involve motor skills (balance, agility, coordination and gait), proprioceptive exercise training and multifaceted activities (tai ji and yoga) to improve physical function and prevent falls in older adults (“ACSM Issues New Recommendations,” 2015). Although neuromotor exercise is recommended and popular outside of the workplace, very few studies have been done in the workplace involving neuromotor exercise.

1.3 Worksite Exercise Programs

1.3.1 Sedentary Work

In a one year randomized controlled trial, 549 office workers were recruited from 12 geographically different units of a national Danish public administration authority (Andersen et al. 2010). They were randomly split into three intervention groups: specific

resistance training, all-round physical exercise, or a reference intervention without physical activity. Pain symptoms were determined by questionnaire screening of twelve selected body regions. Training was performed three times a week and each session lasted 20 minutes. Two of the three weekly sessions were supervised by experienced instructors. In conclusion, the workers given specific resistance training and all around physical exercises caused better effects than a reference intervention in relieving musculoskeletal pain symptoms in exposed regions of the upper body. Additional research is needed to conclude whether or not resistance exercise/training is a preferred method for relieving musculoskeletal symptoms over all-around physical exercise, and/or stretching.

Irmak et al. (2012) performed a 10 week study on 39 healthy office workers which supports that exercise reminder software programs may help to reduce perceived pain. Participants were randomly split into two groups, control (n=19) and intervention group (n=20). Perceived pain and discomfort of the participants were recorded using Visual Analogue Scale (VAS) in the beginning and at the end of the study. The software program featured 53 strengthening, stretching, and posture exercises for all body parts, which were suitable for office environment. The frequency of exercises was two exercises per 45 minutes. This is very cost effective because employees do not even have to leave their station if desired. The difference between the baseline pain levels of the two groups was not statistically significant ($p<0.05$). The change of the VAS scores were calculated and compared. Following the intervention, VAS scores of the intervention group were lower than control group in a statistically significant way ($p<0.005$). The author believes the balance between muscle fatigue and recovery will reduce probability

of occurrence of symptoms. Therefore, exercises suitable for an office environment and frequent rest breaks are recommended to prevent the onset of musculoskeletal pain (Irmak, et al. 2012).

In another study (Henning, et al. 1997), computer operators at two work sites (n=73, n=19) were prompted to take three 30 second and one 3 minute break from computer work each hour in addition to conventional rest breaks. Some were asked to perform stretches during the short break. Mood state and musculoskeletal discomfort were assessed at each work site over a 2- or 3-week baseline period and a 4-or 6-week treatment period, respectively. Operator productivity measures were obtained from company records. Operators complied with about half of the added breaks but favored 3-min breaks over 30-s breaks. At the smaller worksite, productivity, eye, leg and foot comfort all improved when the short breaks included stretching exercises. The results provide evidence that frequent short breaks from continuous computer-mediated work could benefit worker productivity and wellbeing when the breaks integrate with task demands.

Tsauo et al., (2004) implemented three different health promotion exercise programs for work-related shoulder and neck pain among sedentary workers. All three groups in this study were given an informative lecture on the anatomy of neck and shoulder, and stretching exercises for tight muscles surrounding the neck region. The difference between the groups was how the program was executed. One performed by themselves (n=56), another under supervision (n=69), and the third group performed the program twice; once under a physiotherapist's supervision, and once without supervision. There were 39 subjects in the reference group. A modified Nordic questionnaire, pain

threshold and cervical range of motion were used to evaluate the effect of intervention. Exercises included stretching for tight muscles surrounding the neck region and exercise with a full range of cervical motion in three main planes including flexion, extension, side bending and rotation. Each movement was held at the end of range for five seconds and repeated 10 times. On average, each session was about 15 minutes. This was maintained for two weeks until the first stage data collection. The second intervention stage was 2-3 months. Reported soreness data was collected at the beginning, after the first stage (2 weeks) and after the second stage (2-3 months). Data showed a dose-response effect of intervention intensity. It also showed an intensive team-exercise program to be the most beneficial in reducing neck and shoulder symptoms in sedentary workers. This was not an expensive program and no specific devices are needed. Also, the study proved that exercise does not need to take much time, and hence would not severely interrupt employee's work, which might result in lower compliance. Only 1-2 stretch sessions of 15-20 minutes carried out during the workday can have a demonstrable effect. Additional research is needed to confirm the idea/hypothesis that supervised exercise may be more beneficial in reducing musculoskeletal symptoms than non-supervised exercise.

1.3.2 Industrial Work

In 2005, an 11-week study was conducted in Seoul, Korea on 169 subjects working in an electronic parts manufacturing company (Koo & Kim, 2006). The authors surveyed questionnaires about general characteristics, subjective symptoms of musculoskeletal discomforts, the knowledge, attitude and practice of musculoskeletal diseases before and after a preventive stretching exercise program. The stretching exercise was executed for

10 weeks and the education of musculoskeletal diseases was implemented for 1 week. Methods were not clearly explained for this study as to type and duration of each exercise session. Results published in 2006 concluded the change of complaint rate of musculoskeletal symptoms for each body part was not statistically significant however; the change of knowledge, attitude and practice on musculoskeletal diseases after exercise program was statistically significant.

The process used to plan and implement physical activity programs needs to be sensitive, relevant, and responsive to employee interests, group needs, and corporate realities (Pronk, 2009). Comprehensive practices take both the physical and organizational work environment into account while simultaneously addressing the personal health needs of the individual employees and their families. Evidence suggests that an integrated strategy is more effective in preventing disease and promoting health and safety than addressing each component separately (Pronk, 2009).

1.4 Research Objective

Although on-site exercise programs are becoming more prevalent in today's society (Kietrys et al., 2007), especially for sedentary work, comparatively fewer formal studies have been reported for industrial worksites and/or for workers who perform manual labor. Undoubtedly, work life is an important life domain. There are many resources available for corporations to use in order to increase knowledge on the benefits of physical activity and exercise, support the adoption of physical activity routines, and institute a supportive physical and cultural environment for exercise.

The objective of the present study is to explore the relationship between exercise involvements to the wellbeing of the employees in the workplace involving manual work. Safety Managers at the transportation facility where the research was conducted were looking to implement corrective actions after multiple employees reported musculoskeletal injuries and suffered loss work days. The author and the management at the transportation company collaborated on this approach as a corrective measure for the multiple reported back injuries of maintenance worker within a short time span.

The purpose of this study was: (i) to measure the level of support among the maintenance workers at the transportation company for an onsite stretch flex (SF) program, and their perception on the effectiveness the program in treating and preventing work-related musculoskeletal disorders, and (ii) to measure objectively the reduction of chronic pain and discomfort (symptoms of MSD) after implementing an onsite SF program. The results could enable ergonomic, safety and health professionals as well as transportation management to provide maintenance workers with better education about the effectiveness of a SF program in musculoskeletal injury prevention and corrective actions.

CHAPTER 2

METHODOLOGY

2.1 Participants

In this study, maintenance workers at a transportation company in Newark, NJ participated in a stretch and flex (SF) exercise program for 5 weeks. The author solicited participants in this study at three separate shift meetings. The transportation company employed the author at the time, as a Graduate Safety Intern. The experimental study was approved both by the Institutional Review Board (IRB) of NJIT and the manager of the transportation company. The IRB documents are included in Appendix A. A multi-questionnaire survey including an approved consent form was distributed to three groups of employees at the three separate shift meetings on the same day. Number of employees at each shift meeting varied, due to business/operational needs. In total, 62 participants filled out the initial survey with 24 in first shift, 22 in second shift, 14 in third shift and 2 undetermined shifts. Participation was voluntary and all participants were guaranteed confidentiality and anonymity. Volunteer participants submitted before and after program surveys with signed consent. All participants were adult, able-bodied, fulltime employees of the facility. The participants were given a brief overview and demonstration of the experimental procedures before participating in the experiment. Participants were not paid any additional incentive for participation in this on the job experimental study. Their ages ranged from 26-51. Both female (n=5) and male

participants (n=57) were involved. Job role profiles of those who participated in the study were: managers/supervisors, central control operators, engineers, operational technicians, recovery technicians, and stock room technicians. The percentage breakdown of role profiles was not calculated, due to the lack of response to this question on the survey. Although participants were promised confidentiality and anonymity, the author believed this lack of correspondence was due to participant concern of identity disclosure.

2.2 Stretch Flex Exercises

Stretch and flex was chosen as the mode of exercise to counter balance musculoskeletal pain from physical labor. The author herself is trained in exercise science and she is a certified Group Exercise Instructor under the American Council on Exercise. She selected the specific stretches that could prepare the body for everyday work stresses through stretching and strengthening the specific muscles that are commonly associated with strains and sprains. Nationally recognized websites were reviewed, such as http://www.acefitness.org (The American Council on Exercise) and http://www.acsm.org (The American College of Sports Medicine), to select the appropriate stretch flex (SF) exercises.

After studying multiple stretching techniques and stretches for each body part, five stretches were selected based on body part impacted, space available for stretching, and severity/risk of stretch. For space limitation in the facility, the stretches that can be done in standing position were included. Severity level of stretches was kept at beginner's level to avoid risk of injury from exercise.

This stretching routine included a bilateral neck stretch, triceps stretch, shoulder stretch, thigh (quadriceps) stretch, and hamstring stretch. Participants were instructed to perform stretches slowly and deliberately, as well as to never take a stretch past the point of tension strain or pain. Each stretch was instructed to comfortably hold for 15 seconds before switching body part. The total duration (4.5 minutes) was chosen in line with facility supervisor request (less than five minutes), work demands, reviews of previous study timeframes (Choi and Wolentz, 2010), and hypothesized employee attention to program. A short video was created on iMovie, an Apple program and it was then burned onto a CD, which was played back during the SF exercise sessions. The video instructed verbally how to perform each stretch, as well as depicted what position should look like. Background music was played in between instructions. Figure 2.1 displays the images/stretches depicted in the SF video. These images, along with the audio instructions can be found in the CD kept in Appendix B.

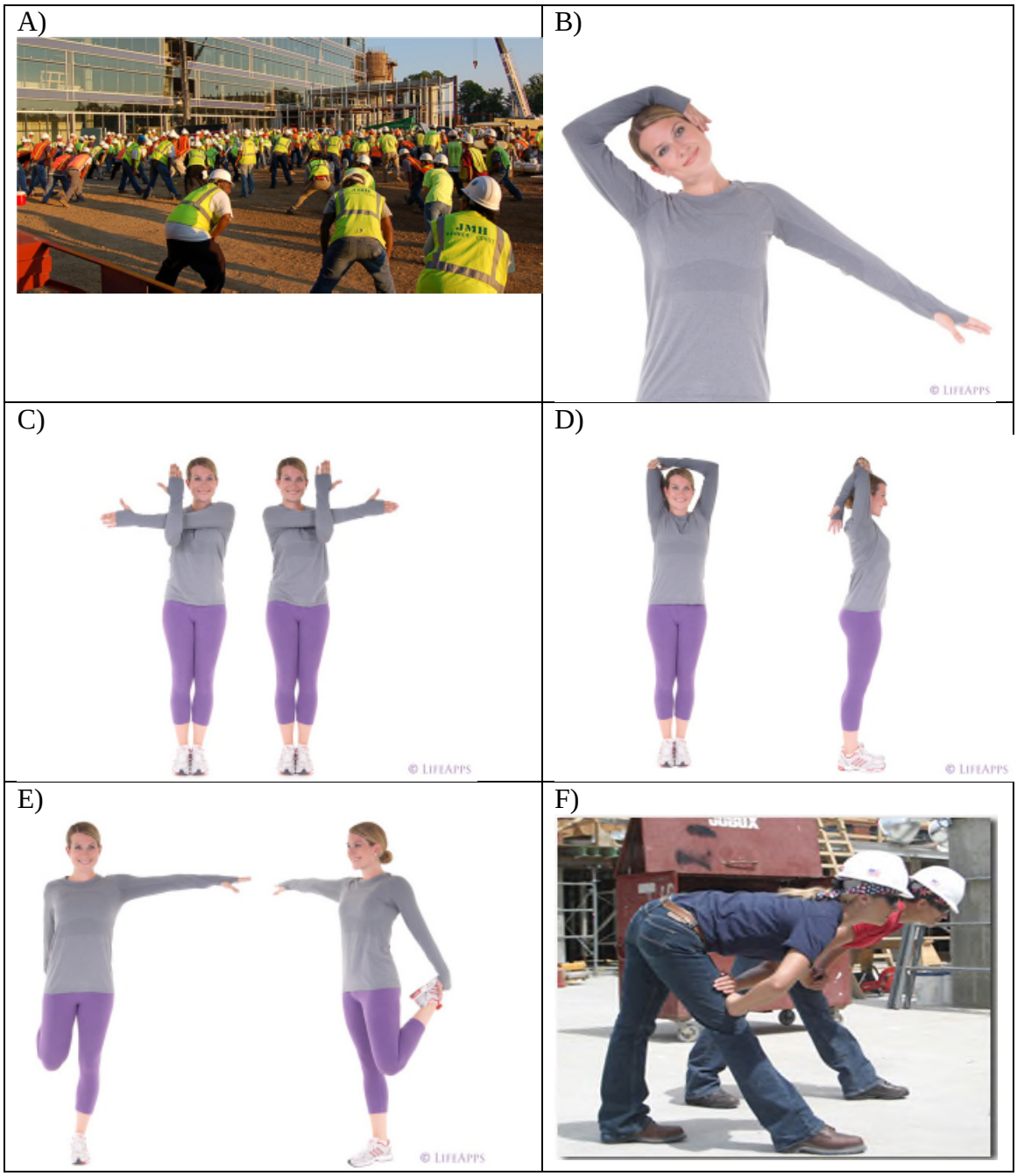


Figure 2.1 Images used during stretch flex exercises training: (A) introductory group exercise photo (B) neck stretch, (C) shoulder stretch, (D) triceps stretch, (E) quadriceps stretch, and (F) hamstring stretch. Each stretch was performed bilaterally. Figures were courtesy from:

http://www.injuryfreeenvironment.com
http://www.mdworkout.com/workout/2011/11/traditional-stretches/

2.3 Survey Questionnaire

Survey tools were chosen after research was done on former studies involving on site exercise programs effects on musculoskeletal disorders, and studies involving measuring pain/discomfort (Chen, Wang…et al. 2012; Kietrys et al. 2007). A quantitative research approach was adopted for the study, which involved the development and distribution of questionnaires as the survey mechanism. After collecting general demographic data such as gender, age, department, job title and shift, the questionnaire included three questions eliciting participant's response of 'Yes' or 'No' on (1) exercise habits, (2) perception of effectiveness of exercise in relieving neck, back and other body discomforts, and (3) willingness to participate in stretching exercise in work.

The next section utilized a visual analog scale (VAS) to record participant's discomfort level in five body regions: neck, shoulder, back, upper extremity and lower extremity. This pain scale has been used in previous studies to analyze levels of discomfort and/or pain (Chen, Wang…et al. 2012). Analog scale included levels: no pain, mild, moderate, severe and as bad as it could be, which corresponded to a scale from 0 to 10, with 0 being no pain and 10 being worst pain. Employees were asked to circle, or make a line on the scale where they deemed their pain level was. The VAS pain scales were followed by a survey instrument known as the 'neck disability index' (NDI).

NDI is a validated survey tool used in similar research (Kietrys et al. 2007) and it was chosen due to the relevancy of the questions related to general musculoskeletal pain. The participants were verbally explained to select appropriate responses related to their musculoskeletal pain, whereas the original survey focused specifically on neck pain. Questions on the NDI addressed how pain affected activities of daily living, such as pain

intensity in personal care, lifting activity, concentration, work, driving, sleeping, and recreation. The author chose to use this tool to analyze how employee discomfort levels were affecting their activities of daily living, before and after the program. She chose to analyze only the activities that may directly or indirectly affect work performance (personal care, lifting, headaches, concentration, work, sleeping, and recreation). The experimenter did not look at the effect of reading or driving, due to employee work tasks involving neither of the two. This tool can also be found in Appendix B.

2.4 Study Design

At the initial introduction to the Stretch and Flex program, workers filled out the survey forms. These same versions of the survey were given at the conclusion of the 5-week program. The survey was filled out at the shift meeting (first, second, and third) at the beginning and end of the experiment. Volunteer participants submitted before and after program surveys with signed consent. They were given the option to fill out the survey on their own time, and leave it on her desk if they did not have enough time to fill it out when it was distributed.

The SF program included a 4½ minute stretching video session that would play at every shift change meeting (known as “pass down meetings”). Each participant would therefore perform the SF exercises approximately five times a week, for 5 weeks. This would total approximately 25 SF program sessions per participant.

Participants were informed that the participation was voluntary, and they were supervised during first and second shift video exercise by the author. She also introduced the exercise video to third shift workers and supervised/participated in the first and final

video session. Due to timing, the nature of shiftwork and 24-7 business operations, she was unable to supervise all shift meetings. The first shift meeting was at approximately 8am everyday, second shift meeting at approximately 4pm everyday, and third shift at approximately 11pm every night.

At the end of each shift change meeting, supervisors were told to play the Stretch and Flex program video. Initial instructions ask participants to spread out to begin stretching, and to give an arms length distance away from anyone near. The lights were shut off for additional privacy. Workers who did not want to participate were given the option to leave the room. Throughout the 5 weeks, workforce numbers changed minimally. A few participants switched shifts during the 5-week program. The experimenter received 62 surveys at the beginning of the program and 51 surveys at the end of the program. This reduction in the number of responses is suspected to be due to some participants not filling out the forms at the end of the survey, which could be due to participant concern for anonymity.

2.5 Data Analysis

The data from the surveys administered before and after 5 weeks of exercise were compiled and analyzed using an Excel spreadsheet, which can be found in the Appendix C. It was found that not all participants responded to all questions; however the overall response rate of the questions was high at 93%. Most questions left blank were those concerning age, gender, and departments, probably because of concern of anonymity. Question #1 also had poor response, probably for the same reason. The remainder of the questions average response rate was more than 95%.

The author chose to recognize question #2 as participant perception of effectiveness, “Do you think stretching exercises are beneficial in relieving neck and back pain or discomfort?” and recognized question #3 as willingness to participate, “Do you want to participate in stretching exercises at work?”

CHAPTER 3

RESULTS

The analyses of the effect of exercise are presented in five separate categories, (1) participants perception and willingness, (2) percent of participants feeling discomfort, (3) average discomfort levels in body regions, (4) average discomfort levels while performing activities of daily living (ADLs), (5) percentages of participants notated discomfort associated with ADLs. A t-test at 95% confidence level was conducted to check the statistical significance of before and after discomfort levels.

3.1 Participants Perception and Willingness

The graph in Figure 3.1 compares “before” and “after” participants’ perception of the effectiveness of the program, and willingness to continue the program. On the “before” surveys, 93% of participants answered ‘yes’ to the question, “Do you think stretching exercises are beneficial in relieving neck and back pain or discomfort?” That percentage dropped slightly, but remained fairly high at 89% after the completion of the 5-week program. As for the willingness, approximately 64% of participants answered ‘yes’ to the question, “Do you want to participate in stretching exercises at work?” before the program was introduced. After the program, the number rose to 81% of participants willing to participate in stretching exercises at work. The indication from this result is that fairly large percent of participants believes in the effectiveness of the program, and more participants felt in favor of the on-site stretching program after the 5 weeks, due to experiencing some type of positive effect.

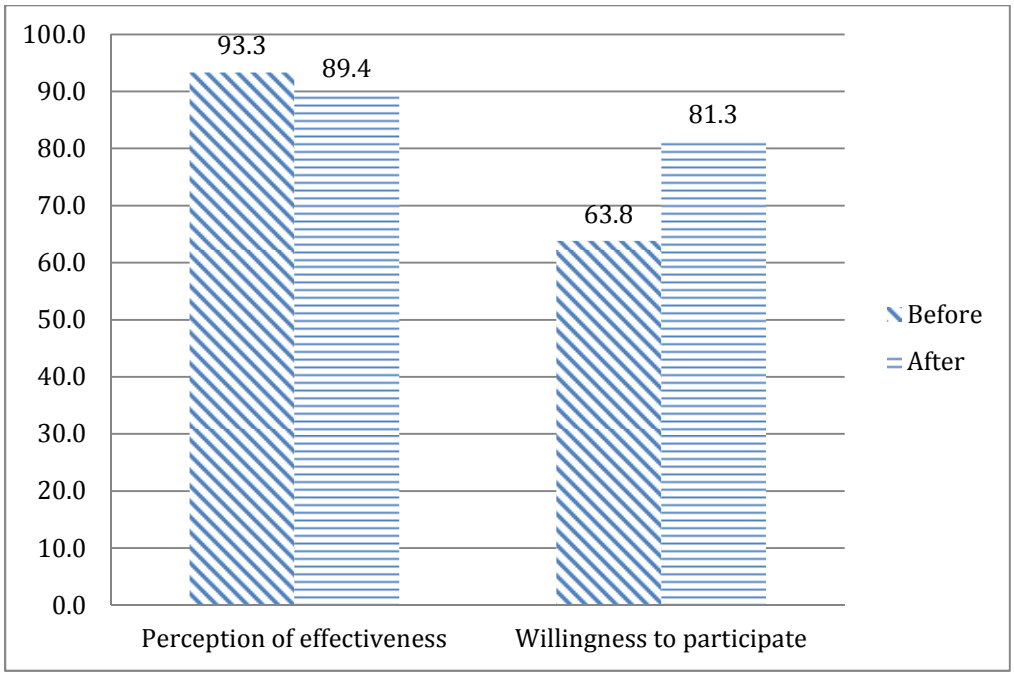


Figure 3.1 Percent of participants with positive attitude towards on-site exercise program, before and after: (a) perception of effectiveness and (b) willingness to participate.

3.2 Percent of Participants Feeling Discomfort

The graph presented in Figure 3.2 compares the percent of participants notated any feeling of discomfort, (1 or more in a scale of 0-5) before and after the SF program. The graph below shows percent of participants noted discomfort reduced from before to after in neck 33.9% to 22.4%; shoulder 38.7% to 37.5%; arm/wrist/finger 37.1% to 31.3%; back 53.2% to 43.8%; and leg/knee/foot 54.1% to 32.1%, respectively.

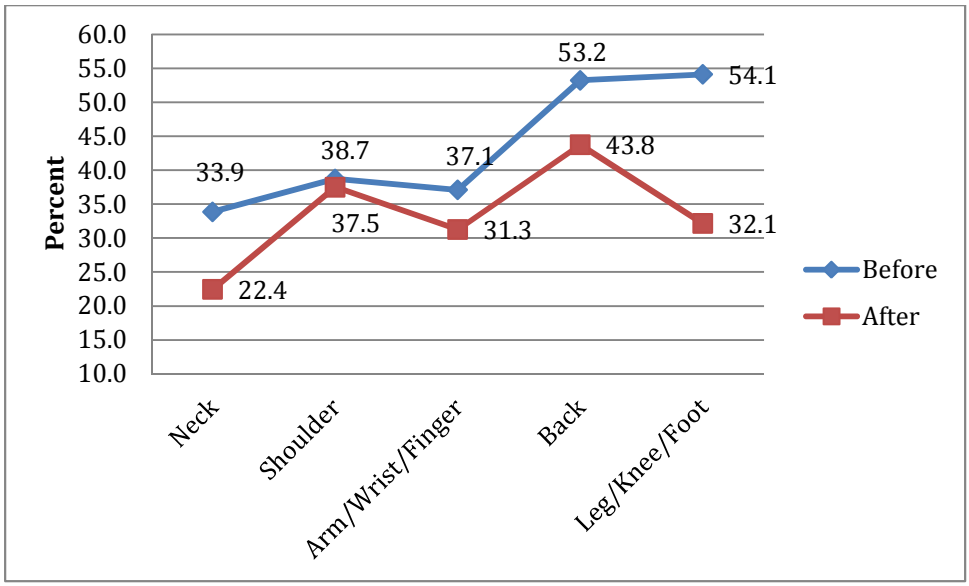


Figure 3.2 Percent of participants with noted discomfort in body regions, before and after.

3.3 Participants' Average Discomfort Levels in Body Regions

On a scale from 0-10, average discomfort levels of participants were analyzed, before and after the SF program. The graph below in Figure 3.3 shows a drop in average discomfort levels of the neck region (1.4 down to 0.76) arms/wrists/fingers (1.4 down to 0.79) and leg/knee/foot region (2.2 down to 1.29) for employees after the five-week SF program. All body regions showed reduction in average discomfort level, with the leg/knee/foot region being the largest decrease. Based on a one tailed equal variance t-test, mean discomfort levels in neck, arm/wrist/finger, and leg/knee/foot significantly ($p<0.1$) reduced from before to after SF program.

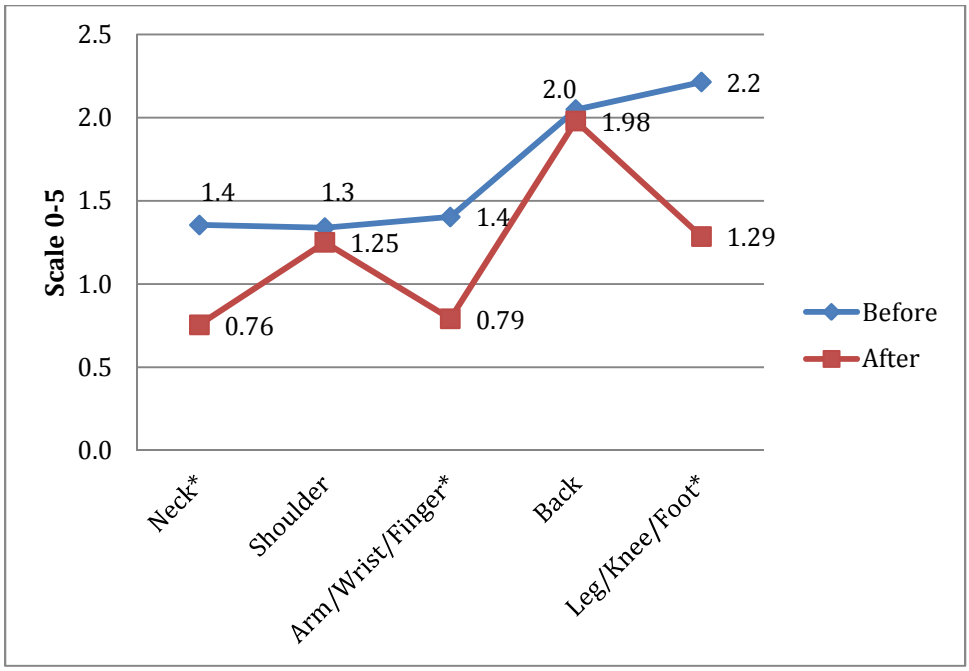


Figure 3.3 The averages discomfort level of participants in body regions, before and after the program. '*' indicates significant ($p<0.1$) reduction of mean discomfort in Neck, Arm/Wrist/Finger, Leg/Knee/Foot in after SF intervention.

3.4 Participants' Average Discomfort While Performing Activities of Daily Living

On a scale from 0-5, the average discomfort levels of employees while performing activities of daily living were compared. Figure 3.4 shows a significant decrease ($p<0.1$) in average employee discomfort after the program while performing personal care (0.3 down to 0.05), and lifting (0.52 down to 0.22) activities. Discomfort levels reduced for employees when it came to headaches, concentration, work activities, sleeping, and recreation, but the reductions were not statistically significant.

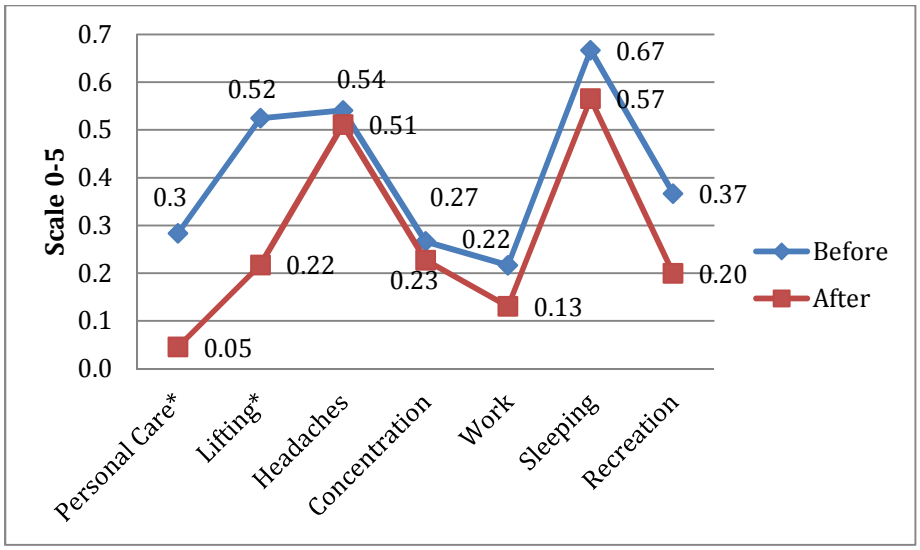


Figure 3.4 The average discomfort level of participants while performing activities of daily living, before and after the program. '*' indicates significant ($p<0.1$) reduction of mean discomfort in Personal Care, Lifting, after SF intervention.

3.5 Percentages of Participants that Notated Discomfort Associated with ADLs

The graph presented in Figure 3.5 shows percentages of participants that notated discomfort associated with activities of daily living (1 or more in a scale of 0-5). The percentage of participants with discomfort while doing personal care, lifting, sleeping, and recreation decreased after the program. Substantial decrease was noted for discomforts associated with personal care (decreased from 15% to 4.5%) and discomforts associated with lifting (decreased from 27.9% to 15.2%). The percentage of participants with difficulties associated with concentration decreased from 18.3% to 18.2%, difficulty associated with work decreased from 11.7% to 10.9%, difficulties associated with sleeping decreased from 30% to 26.1% and discomforts associated with recreation decreased from 26.7% to 20%. The percentage of participants with headaches increased after the program. This is unknown as to why, but theorized to be a chance occurrence.

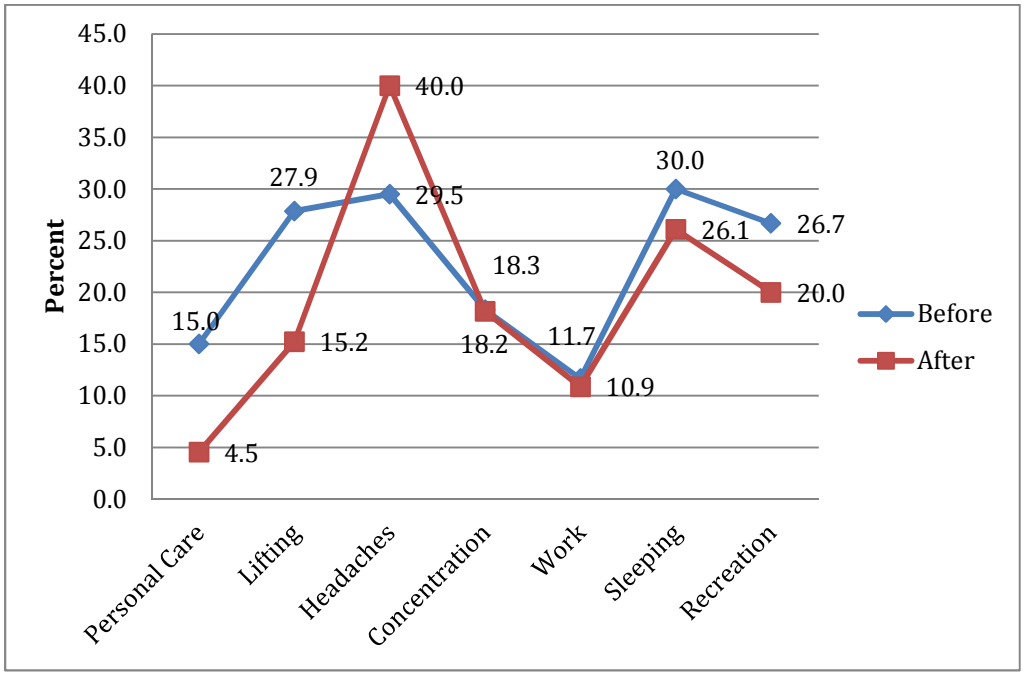


Figure 3.5 The percentage of participants with discomforts associated with activities of daily living (ADLs), before and after the program.

3.6 Discussion

The objective of this study was to identify the perceptions of maintenance workers at a transportation company on the effectiveness of stretch and flex (SF) programs in treating and preventing work-related musculoskeletal disorders. Before the program, 93% of participants believed stretching exercises are beneficial in relieving neck and back pain or discomfort. After the program that percentage dropped slightly, but remained high at 89%. Before the program had begun, 64% of participants wanted to participate in stretching exercises at work. After the program, the number rose to 81% of participants willing to participate in stretching exercises at work.

Percent of participants noted discomfort in different parts of the body ranged from 33.9% to 54.1%, before the intervention, which is quite substantial. Low back and

leg/knee/foot regions were more common site of discomfort noted by more than 50% participants. The figures show, reported pain in body regions before the program was equal to or more common than reported pain in body regions after the program. Average discomfort level for participants after the program either remained the same, or decreased. The percent of participants with discomfort reduced from before to after in neck 33.9% to 22.4%; shoulder 38.7% to 37.5%; arm/wrist/finger 37.1% to 31.3%; back 53.2% to 43.8%; and leg/knee/foot 54.1% to 32.1%, respectively. Figures 3.4 and 3.5, addressing activities of daily living show a significant decrease in the average discomfort level of participants after the program when performing personal care, lifting, working, sleeping, and recreation. On a scale from 0-5, there was a significant decrease in average employee discomfort while performing personal care (0.3 down to 0.05), and lifting (0.52 down to 0.22) activities. The percentage of participants with discomfort while doing personal care, lifting, sleeping, and recreation decreased after the program.

Kietrys et al. (2007) conducted a four-week study involving at-work exercises on computer operators. Subjects (n=72) were split into three groups: resistance exercise, stretching, and control. Participants who did stretching exercises had a higher mean response for the question “I will continue to perform the exercises now that the study is over”, which is similar to this study’s participants willingness to participate percentage increase from 63.8% to 81.3%.

Hartig & Henderson (1999) conducted a 13-week study assessing heavy occupational work, stretching exercise sessions, and MSD. Military recruits performed four stretching sessions per day, with one hamstring stretching exercise, which was held for 30 seconds and repeated five times per session. Subjects who performed stretching

exercises reported significantly less ($p<0.05$) extremity overuse injuries (16.7%) than the control group (29.1%). The experimental/stretching group also showed a significant increase in range of motion (16.8%) compared with subjects who did not perform stretching exercises (6.5%) (Hartig & Henderson, 1999). This is comparable to this study, with a shared method of static stretching, and participant reporting discomfort/pain. Results are similar as well, shown by the percentage of participants reported discomfort in their leg/knee/foot (lower extremity) was 54.1% before the program began, and decreased to 32.1% when the program ended.

Amako et al. (2003) reported in a similar study, military recruits performed 20 minute stretching exercise sessions before and after physical training sessions. Subjects who performed stretching exercises had a significantly lower incidence of muscle/tendon injury (2.5%) and low back pain (1.0%) compared with subjects who did not perform stretching exercises (6.9% and 3.5%, respectively). This is comparable to this study's method of static stretching, and participant reporting discomfort/pain. Results are comparable by the participant's decrease in reported back pain (before the program, 53.2% reported back discomfort, and after 43.8% reported back discomfort).

The similarity of many of the study outcomes with other studies provides an indirect validity of the results of this study. Statistically significant reductions in average discomfort levels, as well as reduction in percent of participants reporting discomfort after a five week SF program strongly suggest that stretching sessions may reduce musculoskeletal discomfort in specific body regions (particularly the back and lower extremities), when held as a static stretch and performed consistently.

CHAPTER 5

CONCLUSION

The existing study investigated the effects of an at-work stretching program on musculoskeletal discomfort in maintenance workers in a transportation company. Stretching was chosen as the method for relieving musculoskeletal discomfort due to the nature of maintenance work, employee injuries, and literature review that indicated positive effects. The population chosen was due to employee injury rate, which was higher than the company office employee injury rate. A need to counteract the nature of work and to support promotion of physical activity at the workplace is evident. This was not an expensive program and no specific devices were needed for stretching. Also, the exercise does not need to take much time, and hence would not severely interrupt company operation or employee's work, which might result in lower compliance. Only one stretch session of approximately five minutes carried out during the workday can have a remarkable effect in reducing pain and discomfort from MSD, if performed consistently over time.

One of the limitations of the study was the absence of control group of participants, for comparing before and after results. Due to the limitation of time and the management obligations, a control group could not be implemented. One important limitation of the study was that no control group was present. Also based on the study results, long term effect of such program in reducing MSD incidents cannot be predicted, Additional research is needed to confirm this.

APPENDIX A

IRB CERTIFICATION

This appendix shows the original thesis proposal created by the author, and written to the Institutional Review Board at NJIT.

NJIT New Jersey's Science & Technology University

Institutional Review Board: HHS FWA 00003246 Notice of Approval

IRB Protocol Number: F 203-14

Principal Investigators: Kellie Caldwell Arijit Sengupta

Department: Mechanical and Industrial Engineering

Title: On-Site Stretch and Flex Exercise Program and Employee Health and Wellbeing at Bombardier Transportation

Performance Site(s): Off Campus – 60 Earhart Drive, Newark, NJ

Type of Review: FULL [x] Type of Approval: NEW [x]
Approval Date: July 16, 2014

EXPEDITED [ ] RENEWAL [ ] REVISION [ ]

Expiration Date: July 15, 2015

1. **ADVERSE EVENTS:** Any adverse event(s) or unexpected event(s) that occur in conjunction with this study must be reported to the IRB Office immediately (973) 596- 5825. □

2. **RENEWAL:** Approval is valid until the expiration date on the protocol. You are required to apply to the IRB for a renewal prior to your expiration date for as long as the study is active. It is your responsibility to ensure that you submit the renewal in a timely manner. □

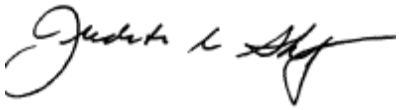
3. **CONSENT:** All subjects must receive a copy of the consent form as submitted. Copies of signed consent forms must be kept on file with the principal investigator. □

4. **SUBJECTS:** Number of subjects approved: 60 □

5. The investigator(s) did not participate in the review, discussion, or vote of this protocol. □

6. Only data collected that has participant consent may be used in published research. □

7. APPROVAL IS GRANTED ON THE CONDITION THAT ANY DEVIATION FROM THE PROTOCOL WILL BE SUBMITTED, IN WRITING, TO THE IRB FOR SEPARATE REVIEW AND APPROVAL. □



Judith Sheft, IRB Chair,

APPENDIX B

SURVEY INSTRUMENTS

Figures B.1 to B.3 are the survey questionnaires distributed to participants.

NECK PAIN DISABILITY INDEX QUESTIONNAIRE

PLEASE READ: This questionnaire is designed to enable us to understand how much your neck pain has affected your ability to manage your everyday activities. Please answer each section by circling the ONE CHOICE that most applies to you. We realize that you may feel that more than one statement may relate to you, but PLEASE JUST CIRCLE THE ONE. CHOICE, WHICH MOST CLOSELY DESCRIBES YOUR PROBLEM RIGHT NOW.

SECTION 1 - Pain Intensity A I have no pain at the moment. B The pain is very mild at the moment. C The pain is moderate at the moment. D The pain is fairly severe at the moment. E The pain is very severe at the moment. F The pain is the worst imaginable at the moment.	**SECTION 6 - Concentration** A I can concentrate fully when I want to with no difficulty. B I can concentrate fully when I want to with slight difficulty. C I have a fair degree of difficulty in concentrating when I want to. D I have a lot of difficulty in concentrating when I want to. E I have a great deal of difficulty in concentrating when I want to. F I cannot concentrate at all.
SECTION 2 -Personal Care (Washing, Dressing, etc.) A I can look after myself normally without causing extra pain. B I can look after myself normally, but it causes extra pain. C It is painful to look after myself and I am slow and careful. D I need some help, but manage most of my personal care. E I need help every day in most aspects of self-care. F I do not get dressed, I wash with difficulty and stay in bed.	**SECTION 7 - Work** A I can do as much work as I want to. B I can only do my usual work, but no more. C I can do most of my usual work, but no more. D I cannot do my usual work. E I can hardly do any work at all. F I cannot do any work at all.
SECTION 3 - Lifting A I can lift heavy weights without extra pain. B I can lift heavy weights, but it gives extra pain. C Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, for example, on a table. D Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned. E I can lift very light weights. F I cannot lift or carry anything at all.	**SECTION 8 - Driving** A I can drive my car without any neck pain. B I can drive my car as long as I want with slight pain in my neck. C I can drive my car as long as I want with moderate pain in my neck. D I cannot drive my car as long as I want because of moderate pain in my neck. E I can hardly drive at all because of severe pain in my neck. F I cannot drive my car at all.
SECTION 4 - Reading A I can read as much as I want to with no pain in my neck. B I can read as much as I want to with slight pain in my neck. C I can read as much as I want to with moderate pain in my neck. D I cannot read as much as I want because of moderate pain in my neck. E I cannot read as much as I want because of severe pain in my neck. F I cannot read at all.	**SECTION 9 - Sleeping** A I have no trouble sleeping. B My sleep is slightly disturbed (less than 1 hour sleepless). C My sleep is mildly disturbed (1-2 hours sleepless). D My sleep is moderately disturbed (2-3 hours sleepless). E My sleep is greatly disturbed (3-5 hours sleepless). F My sleep is completely disturbed (5-7 hours)
SECTION 5 - Headaches A I have no headaches at all. B I have slight headaches which come infrequently. C I have moderate headaches which come	**SECTION 10 - Recreation** A I am able to engage in all of my recreational activities with no neck pain at all. B I am able to engage in all of my recreational activities

infrequently. D I have moderate headaches which come frequently. E I have severe headaches which come frequently. F I have headaches almost all the time.	with some pain in my neck. C I am able to engage in most, but not all of my recreational activities because of pain in my neck. D I am able to engage in a few of my recreational activities because of pain in my neck. E I can hardly do any recreational activities because of pain in my neck. F I cannot do any recreational activities at all.

Figure B.1 Neck Disability Index (distributed to participants before and after the program).

Age: **Gender: M F**

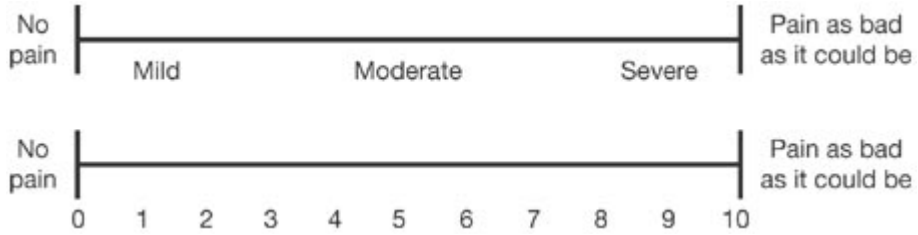
Department/Job Title: **Shift:** 1st 2nd 3rd

1.) Do you do stretching exercises regularly? Yes No

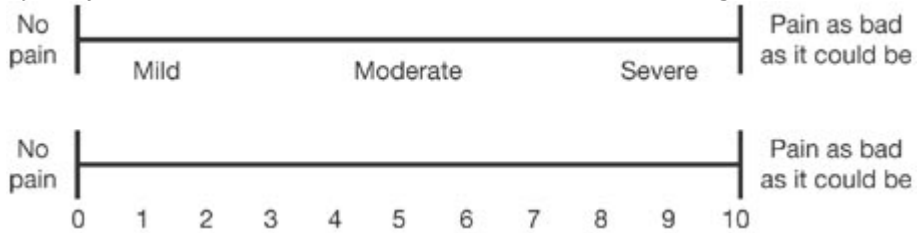
2.) Do you think stretching exercises are beneficial in relieving neck and back pain or discomfort? Yes No

3.) Do you want to participate in stretching exercises at work? Yes No

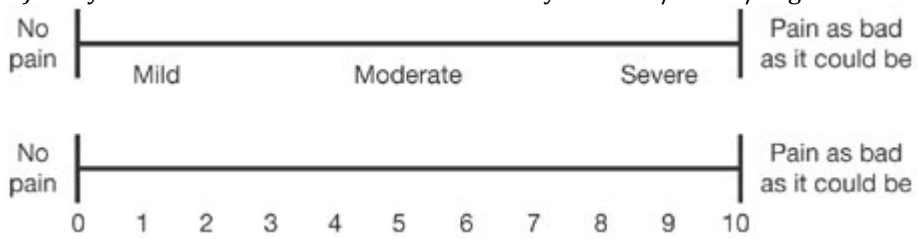
4.) Do you have musculoskeletal discomfort in the neck region? Yes No



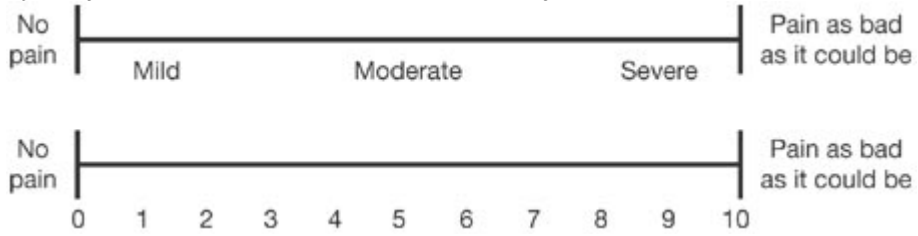
5.) Do you have musculoskeletal discomfort in the shoulder region?



6.) Do you have musculoskeletal discomfort in your arms/wrists/fingers?



7.) Do you have musculoskeletal discomfort in your lower back?



8.) Do you have musculoskeletal discomfort in your leg/knee/foot?

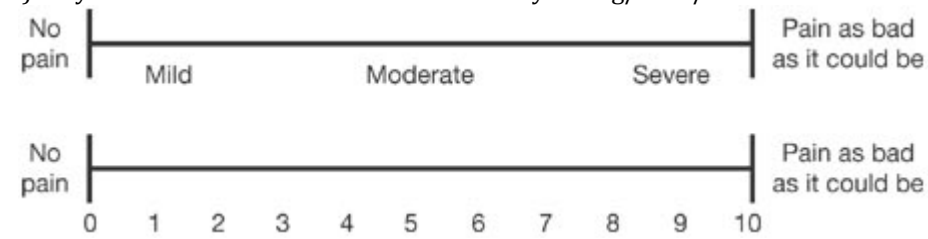


Figure B.2 Visual analog scale of body pain index.

APPENDIX C

INSTRUCTIONAL INSTRUMENT

The following images on the left were displayed in the movie. The wording on the right was the audio instructions for each image in the video. Each image was visually displayed for a total of 30 seconds. For images B-F, after the first 15 seconds, participants were instructed to “switch sides” on the audio. This was to ensure both sides of the body were being stretched.

A) 	A) Stretching can prepare the body for everyday work stresses. This is done through stretching and strengthening the specific muscles that are commonly associated with strains and sprains. If performed correctly and regularly, these exercises may reduce the incidences of muscle strain and sprains. Stretches should be performed slowly and deliberately. Never take a stretch past the point of tension strain or pain.
B) 	B) Neck Stretch: Tilt head sideways without twisting the neck. Using your hand, reach across head and move ear toward shoulder. Do not pull head. Use weight of arm alone. Extend other arm.
C) 	C) Shoulder Stretch: Stand and place right hand on left shoulder. With left hand, pull right elbow across chest toward left shoulder and hold.
D) 	D) Triceps Stretch: Lift one arm overhead. Bend at the elbow, place your palm on the center of your back and reach down towards your spine. Keep shoulders relaxed, away from the ears.

E.) 	E.) Thigh Stretch Lift one leg and grasp with your arm. Pull up on leg at ankle to stretch thigh. Maintain balance by extending your opposite arm sideways.
F.) 	F.) Hamstring Stretch Place one foot out in front of the other. Keeping the hips facing forward, bring your chest down towards your knee. If you can, touch your toes.

APPENDIX D

EXPERIMENTAL DATA AND ANALYSIS

Tables D.1 to D.4 show survey responses before and after the program, implemented into excel tables.

Table D.1 Survey Responses Before Implementation of Stretch Flex Exercise Program

Subject	Age	Gender	Shift	Psychology	Motivation	Discomfort (Scale 0-10)					Discomfort (Scale 0-5)						
						Neck	Shoulder	Arm/Wrist	Low Back	Leg/ Foot	Personal Care	Lifting	Headaches	Concentration	Work	Sleeping	Recreation
1	NS	NS	NS	NS	1	0	0	0	0	0	0	0	0	0	0	0	0
2	48	M	1	1	1	0	0	0	0	5	0	0	0	0	0	NS	NS
3	NS	M	1	1	1	0	0	0	0	3	0	0	0	0	0	0	0
4	37	M	1	1	0	1	2	1	3	8	0	0	0	0	0	4	1
5	NS	M	1	0	0	2	2	1	8	1	0	0	1	1	1	1	0
6	NS	NS	NS	1	1	0	1	0	1	1	0	2	0	0	0	0	0
7	NS	M	1	1	1	0	1	0	2	2	0	0	0	0	0	0	0
8	NS	M	1	1	NS	0	0	0	0	0	0	4	2	0	0	2	0
9	NS	M	1	1	1	0	0	5	4	0	0	1	0	0	0	0	0
10	NS	M	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
11	NS	M	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
12	NS	M	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
13	NS	M	1	1	1	0	0	3	3	NS	0	1	0	0	0	1	1
14	NS	M	1	1	1	4	3	5	5	5	NS	2	0	0	NS	0	1
15	35	M	1	1	1	5	5	1	7	3	1	1	5	0	0	1	1
16	30	M	1	1	1	2	1	0	4	4	0	0	1	0	0	0	0
17	27	M	1	1	1	0	0	0	2	1	0	1	0	0	0	0	0
18	30	M	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0
19	34	M	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
20	NS	M	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0
21	28	M	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
22	47	M	2	1	0	4	6	8	8	6	1	3	5	1	2	1	1
23	NS	M	2	1	1	5	5	3	2	6	0	0	1	1	0	2	1
24	36	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
25	30	M	2	1	1	5	5	5	5	5	0	0	0	0	0	4	0
26	31	M	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	NS	M	2	1	1	9	9	7	7	4	3	3	0	0	0	0	2

Table D.1 Survey Responses Before Implementation of Stretch Flex Exercise Program (Continued)

Subject	Age	Gender	Shift	Psychology	Motivation	Discomfort (Scale 0-10)					Discomfort (Scale 0-5)						
						Neck	Shoulder	Arm/Wrist	Low Back	Leg/Foot	Personal Care	Lifting	Headaches	Concentration	Work	Sleeping	Recreation
28	NS	M	2	1	1	4	2	4	5	4	0	0	0	0	0	0	0
29	NS	M	2	1	1	0	0	2	0	2	0	0	0	0	0	0	0
30	NS	M	2	1	1	0	0	0	1	4	0	0	0	0	0	0	0
31	52	M	2	1	0	2	2	2	2	2	0	0	1	0	0	0	1
32	24	M	2	1	1	2	2	0	1	0	0	0	0	0	0	0	0
33	NS	M	2	0	1	0	0	0	1	1	0	0	1	0	0	0	0
34	NS	M	2	1	1	10	10	10	10	10	5	5	5	5	5	5	5
35	NS	M	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
36	NS	M	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
37	NS	M	2	NS	0	0	0	0	0	0	NS	NS	NS	NS	NS	NS	NS
38	NS	M	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
39	NS	M	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0
40	NS	M	3	1	1	6	8	0	9	3	1	0	0	1	0	1	1
41	NS	M	3	1	1	2	0	2	2	0	2	1	0	1	1	2	1
42	NS	M	3	1	1	0	0	0	0	0	0	0	1	0	0	4	0
43	NS	M	3	1	1	0	0	1	0	1	0	0	1	0	1	0	0
44		M	1	1		3	5	3	5	5	0	0	0	0	0	0	0
45	39	M	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0
46		M	1	1		4	1	2	2	4	0	1	0	1	0	0	0
47	31	M	1	1	0	0	1	5	1	5	1	1	1	1	1	1	0
48	50	M	1	1	0	0	0	0	2	0	0	0	0	0	0	0	0
49	50	1	2	1	1	7	0	7	6	7	0	1	0	0	0	0	1
50	28	1	2	1		0	0	0	0	5	0	0	0	0	0	0	0
51	31	M	2	1	1	0	0	0	0	0	0	0	0	0	0	2	0
52	69	M	2	1	1	0	0	0	0	1	0	0	0	0	0	0	0
53	26	M	2	1	1	0	2	0	2	5	0	0	0	0	0	0	0
54	26	M	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Table D.1 Survey Responses Before Implementation of Stretch Flex Exercise Program (Continued)

Subject	Age	Gender	Shift	Psychology	Motivation	Discomfort (Scale 0-10)					Discomfort (Scale 0-5)						
						Neck	Shoulder	Arm/Wrist	Low Back	Leg/Foot	Personal Care	Lifting	Headaches	Concentration	Work	Sleeping	Recreation
55	28	1	3	1	0	4	3	6	5	7	0	0	2	2	0	4	2
56	32	1	3	1	0	0	0	0	0	7	0	1	2	NS	0	1	1
57	29	M	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0
58	51	M	3	1	1	0	0	0	5	0	1	1	0	1	0	0	1
59	50	M	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0
60	31	M	3	1	1	1	3	1	1	0	0	0	1	0	0	1	0
61	28	M	3	1	1	0	0	0	1	0	0	0	0	0	0	0	0
62	33	1	3	1	0	2	3	3	5	5	2	3	1	1	2	3	1

Table D.2 Survey Responses After Five Week of Stretch Flex Exercise Program

Subject	Age	Gender	Shift	Psychology	Motivation	Discomfort (Scale 0-10)					Discomfort (Scale 0-5)						
						Neck	Shoulder	Arm/Wrist	Low Back	Leg/Foot	Personal Care	Lifting	Headaches	Concentration	Work	Sleeping	Recreation
1	30	NS	NS	1	1	0	0	0	0	NS	NS	0	0	NS	0	0	NS
2	NS	NS	NS	1	0	0	4	0	6	NS	0	0	0	0	0	0	0
3	NS	NS	NS	1	1	0	0	0	3	0	0	0	0	0	0	0	0
4	NS	NS	NS			1	0	0	0	0	0	0	NS	0	0	0	0
5	NS	M	1	1	0	0	0	0	0	NS	0	0	0	0	0	0	0
6	NS	M	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
7	35	M	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
8	40	NS	1	0	1	5	6	5	8	5	0	0	1	1	0	2	1
9	41	NS	1	1	1	0	1	1	1	1	0	0	1	0	0	0	0
10	58	NS	NS	1	1	0	0	0	0	0	0	0	0	0	0	0	0
11	64	M	1	1	1	0	0	0	0	0	0	2	0	1	0	0	0
12	NS	NS	NS	1	1	0	0	0	1	NS	0	0	0	0	0	2	0
13	NS	M	1	1	1	0	0	0	5	0	0	1	0	0	0	0	0
14	NS	M	1	1	1	5	4	4	4	3	NS	0	0	0	1	0	0
15	50	M	1	1	1	0	NS	NS	NS	NS	0	0	0	0	0	0	0
16	NS	M	1	1	1	0	5	5	5	6	0	0	1	1	1	0	1
17	26	M	1	1	1	5	5	1	9	0	NS	NS	NS	NS	NS	NS	NS
18	30	M	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	42	M	2	1	1	0	0	2	0	NS	0	0	1	0	0	0	0
20	27	M	2	1	1	0	0	0	0	NS	0	0	1	0	0	2	0
21	46	M	2	1	1	2	1	1	4	NS	0	0	0	0	0	0	1
22	31	M	2	1	1	0	0	0	0	NS	0	0	0	0	0	0	0
23		M	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
24		M	2			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
25			3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	60	M	3	1	1	0	0	0	4	NS	0	3	1	0	0	1	0
27	50	M	3	1	0	8	4	1	7	NS	0	0	3	0	0	2	1

Table D.2 Survey Responses After Five Week of Stretch Flex Exercise Program (continued)

Subject	Age	Gender	Shift	Psychology	Motivation	Discomfort (Scale 0-10)					Discomfort (Scale 0-5)						
						Neck	Shoulder	Arm/Wrist	Low Back	Leg/Foot	Personal Care	Lifting	Headaches	Concentration	Work	Sleeping	Recreation
28	27	M	3		1	0	2	0	0	NS	0	0	0	0	0	0	0
29	36	M	3	1	1	0	0	3	0	5	0	0	1	0	0	0	0
30	57	M	3	1	1	3	3	0	0	NS	1	1	0	1	1	0	1
31	36	M	3	0	1	0	3	0	0	NS	0	0	0	0	0	0	0
32	42	M	3	1	1	0	0	0	0	NS	0	0	0	0	0	0	0
33		M	1	1	1	0	5	5	5	5	0	0	0	0	0	0	0
34	39	M	1	1	1	0	3	0	0	0	NS	NS	NS	NS	NS	NS	NS
35		M	1	1	1	3	0	0	4	0	0	0	1	0	0	1	0
36	31	M	1	1	0	0	0	1	2	2	0	0	1	2	2	3	0
37	50	M	1	1	1	0	1	1	4	1	0	0	0	0	0	0	0
38	50	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
39	28	1	2			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
40	31	M	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
41	69	M	2	1	1	0	0	0	0	0	NS	NS	NS	NS	NS	NS	NS
42	26	M	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
43	26	M	3	1	1	2	7	3	6	0	0	0	1	0	0	0	1
44	28	1	3	1	1	0	3	3	6	8	0	1	3	2	0	3	0
45	32	1	3	1	1	0	0	0	0	NS	0	0	1	0	0	2	1
46	29	M	3	1	1	0	1	0	5	NS	0	1	2	1	1	1	0
47	51	M	3	1	1	0	0	0	3	NS	1	1	1	NS	0	0	1
48	50	M	3	1	0	0	0	0	0	NS	0	0	0	1	0	5	0
49	31	M	3	1	1	2	2	2	3	NS	0	0	1	0	0	2	1
50	28	M	3	1	1	0	0	0	0	0	0	0	1	0	0	0	0
51	33	1	3	1	0	0	0	0	0	NS	0	0	1	0	0	0	0

Table D.3 Summary Response Before Implementation of the Stretch Flex Exercise Program

Before	Psychology	Motivation	Discomfort (Scale 0-10)					Discomfort (Scale 0-5)						
			Neck	Shoulder	Arm/Wrist	Low Back	Leg/Foot	Personal Care	Lifting	Headaches	Concentration	Work	Sleeping	Recreation
Total	62	62	62	62	62	62	62	62	62	62	62	62	62	62
Responded	60	58	62	62	62	62	61	60	61	61	60	60	60	60
Yes (1-5)	56	37	21	24	23	33	33	9	17	18	11	7	18	16
no	4	21	41	38	39	29	28	51	44	43	49	53	42	44
yes%	93.3	63.8	33.9	38.7	37.1	53.2	54.1	15.0	27.9	29.5	18.3	11.7	30.0	26.7
No%	6.7	36.2	66.1	61.3	62.9	46.8	45.9	85.0	72.1	70.5	81.7	88.3	70.0	73.3
Average pain			1.35	1.34	1.40	2.05	2.21	0.28	0.52	0.54	0.27	0.22	0.67	0.37

Table D.4 Summary Response After Five Week of Stretch Flex Program and T-tests of Difference in Mean Discomfort Levels

After	Psychology	Motivation	Discomfort (Scale 0-10)					Discomfort (Scale 0-5)						
			Neck	Shoulder	Arm/Wrist	Low Back	Leg/Foot	Personal Care	Lifting	Headaches	Concentration	Work	Sleeping	Recreation
Total	51	51	51	51	51	51	51	51	51	51	51	51	51	51
Responded	47	48	49	48	48	48	28	44	46	45	44	46	46	45
Respse rate %	92	94	96	94	94	94	55	86	90	88	86	90	90	88
yes	42	39	11	18	15	21	9	2	7	18	8	5	12	9
no	5	9	38	30	33	27	19	42	39	27	36	41	34	36
yes%	89.4	81.3	22.4	37.5	31.3	43.8	32.1	4.5	15.2	40.0	18.2	10.9	26.1	20.0
No%	10.6	18.8	77.6	62.5	68.8	56.3	67.9	95.5	84.8	60.0	81.8	89.1	73.9	80.0
Average pain			0.76	1.25	0.79	1.98	1.29	0.05	0.22	0.51	0.23	0.13	0.57	0.20
t-test* before - after			0.070	0.417	0.061	0.447	0.057	0.036	0.042	0.440	0.383	0.244	0.334	0.102

***** Excel formula: =T.TEST(Before!H8:H69,After!H5:H55,1,2

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