Stretching to Prevent Musculoskeletal Injuries
An Approach to Workplace Wellness

by Rosanna M. Gartley, CRNP, DNP, and J. Lynn Prosser, CRNP, DNP

RESEARCH ABSTRACT

A pre-shift stretching protocol to reduce employee injuries was initiated at a beverage company and a tin mill in the northeastern United States. The primary goal of this study was to determine the effects of a pre-shift stretching program on work-related musculoskeletal injuries. A secondary goal was to evaluate daily participation compliance during the 90-day program. Data on employee injuries during the stretching program were collected and compared to injury events during the same time period 1 year earlier. Comparison to injury events of the total eligible population during the study time frame was also included. Results of this pilot program in terms of injury rate reduction and participant compliance are promising. Study results may be useful for employers considering implementing similar programs and also suggest the need for further study in this area.

Work-related injuries incur substantial financial costs for businesses. Jobs requiring heavy and repetitive labor place employees’ health and well-being at risk and incur societal costs as well. Some studies (Praemer, Furner, & Rice, 1999) indicate work-related injuries cost as much as $215 billion per year. However, the cost of injuries cannot be expressed solely in dollars and cents, as injured workers also experience pain, suffering, and decreased quality of life.

The most common physical injuries to laborers are those involving tendons, ligaments, and muscles. Review of the current literature offered few studies focused on the relationship between stretching and the prevention of work-related musculoskeletal injuries. Published stretching studies show conflicting outcomes and demonstrate the need for further research in this area. Heavy loads and repetitive movement can result in tissue overload and subsequent soft-tissue injuries (Kumar, 2001). To reduce injuries, the literature supports adapting jobs to suit workers, but the more common approach is adapting workers to jobs. Inflexibility has been implicated as the cause of sprains and strains (Hess & Hecker, 2003). Studies show that stretching increases flexibility, improves range of motion, and promotes correct form and function, resulting in decreased injuries (Weerapong, Hume, & Kolt, 2004). This strategy, used by athletes, is now being adopted by some workplaces. Because workplace stretching programs require time and money, determining outcomes is important.
STUDY PURPOSE

The primary purpose of this study was to determine the effect of pre-shift stretching on employee injury rates. A secondary purpose was to determine the daily stretching compliance of the participants. Additional study data were used to determine site-specific costs to direct resource allocation.

In 2006, the U.S. Department of Labor reported the injury rate for transportation and warehouse employees was 6.5%, acknowledging that this figure might be underreported as much as 10% (Bureau of Labor Statistics, 2007). One beverage company employed approximately 180 warehouse and delivery driver employees. Between January and September 2008, 67 workers suffered 73 injuries; 66% of the injuries were musculoskeletal. According to workers' compensation figures, the beverage company spent $3,900 per nonsurgical injury. With an average of 93 injuries per year, the company spends $362,700. One tin mill employed approximately 1,200 workers. Between January and December 2008, the company paid an average of $3,500 for each of 238 injuries. The average annual cost of injuries at this location was $840,000.

The study investigators were two occupational health nurse practitioners who routinely treat employees with work-related musculoskeletal injuries. Both companies implemented a pre-shift, stretching, pilot program to reduce work-related musculoskeletal injuries.

LITERATURE REVIEW

The literature review revealed several studies on the relationship between stretching and prevention of soft-tissue injuries outside the work environment. A prospective study conducted with 469 military recruits suggested a positive relationship between stretching before physical activity and decreased soft-tissue injuries (Amako, Oda, Masuoka, Yokoi, & Campisi, 2003). However, a systematic review conducted by Yeung and Yeung (2001) produced insufficient evidence that stretching decreases lower limb injuries in runners. Four systematic reviews of 25 studies also failed to demonstrate a relationship between stretching and exercise-related injury (Fradkin, Gabbe, & Cameron, 2006; Small, McNaughton, & Matthews, 2008; Thacker, Gilchrist, Stroup, & Kimsey, 2004; Weldon & Hill, 2003). Although eight studies showed an increase in injuries following stretching, 17 did not. The majority of research has been conducted with athletes, whose characteristics are unlike those of the average worker. This limitation makes it difficult to generalize the results to workers. A systematic review of seven studies was inconclusive (da Costa & Vieira, 2008). A second systematic review (Hess & Hecker, 2003) examined three studies conducted between 1990 and 1998. The studies described associations between flexibility and stretching and the incidence of work-related musculoskeletal injuries. All three studies were inconclusive. Only one study (Robinette, 2007) found a relationship between stretching and reduction of work-related musculoskeletal injuries. Robinette (2007) found a 60% decrease in United Parcel Service compensation costs in 2005 after implementation of an "industrial athlete" program that included stretching. However, extraneous variables, particularly the focus on workplace ergonomics, did not allow a direct link to be established between injury prevention and stretching.

The current literature raises numerous questions: Who should stretch, and what are the recommendations for the duration and type of stretching? When should stretching take place? Can stretching lessen injury severity and lower compensation costs? Although beyond the scope of this program, these questions demonstrate the need for further inquiry regarding stretching in the work environment.

METHODS

This study used a nonrandomized, descriptive, prepost intervention design. It was conducted at two industrial sites: a beverage company and a tin mill with manual laborers. Both facilities have on-site occupational health clinics, employing each study investigator. The primary purpose of the study was to describe the effect of a pre-shift stretching program, the independent variable, on the number of work-related musculoskeletal injuries between December 2009 and March 2010 (T2). The injury rate during the intervention period was compared to injury rates for all eligible employees between December 2008 and March 2009 (T1) as well as to the injury rates for all eligible employees during (T2). The effect of the program was also described in relation to participant compliance.

Description of the Sample

The convenience sample consisted of volunteer workers from two separate companies. Beverage company volunteers included 37 warehouse loaders and 18 delivery drivers engaged in manual labor. Warehouse loaders lift 35 to 50 pounds per carry, hundreds of times during an 8-hour shift. The second group, delivery drivers, handle product between the warehouse and customer locations. A delivery driver routinely handles 16,000 to 24,000 pounds daily. The tin mill participants, labeled general laborers, work by lifting, carrying, pushing, and pulling up to 100 pounds per task.

Demographics of the group appear in Table I. Forty-seven percent of study participants were warehouse
personnel, 23% were delivery drivers, and 30% were tin mill laborers. Only one participant was female.

Full-time, injury-free employees who began each workday at the facility could participate. Participants in the exercise program were excluded if they incurred a work-related musculoskeletal injury during the study period.

Attrition was attributed to employment changes. Sixteen (16.8%) of the original 95 participants were laid off from the tin mill 1 month into the study. Also, one participant (1.1%) at the beverage company suffered a job-related muscle strain, making him ineligible to complete the study. However, this participant was included in the data analysis.

**Program Planning**

The program was initiated at a beverage company and a tin mill. Both companies are part of international corporations; they are located in demographically similar urban areas. Each study location has an on-site occupational health clinic that employs the study investigators, both of whom are nurse practitioners and candidates for the Doctor of Nursing Practice degree at Robert Morris University.

**Program Protocol**

Approximately 4 months prior to program initiation, management at both company locations were informed of the program’s details. A chiropractor specializing in stretching protocols was consulted to assist with program design. The program consisted of nine stretches, targeting the neck, shoulders, upper and lower back, quadriceps, hamstrings, arms, and ankles (Table 2). Each stretch was held for 10 to 15 seconds. All stretching was done in a standing position without the use of props.

After securing written permission from company management and Robert Morris University’s Institutional Review Board, the investigators addressed eligible employee groups. The program was described, questions were answered, and employees were given the opportunity to participate. Volunteer participants signed written consent forms.

One week prior to the start of the study, participants received a paper copy of the stretching protocol. During this week, the stretching specialist led beverage company managers through the stretches to familiarize them with the program’s components. To assist employees in learning proper stretching techniques, wall-sized posters of the stretches were hung in the stretching areas.

Tin mill and driver participants determined their own daily time and location for stretching. Some drivers chose to stretch before beginning their route, whereas others waited until reaching their first delivery stop. Prior to the beginning of each warehouse shift, supervisors led the stretching program.

To ensure proper tracking of volunteer participation, a daily compliance roster was maintained by each warehouse shift leader. Drivers and tin mill participants kept their own stretching logs.

On day 1 of the program at the beverage company, balloons were hung, a meal was provided, photographs were taken, and a large thank you banner was hung in the lunch room. As the study progressed, incentives were offered to encourage continued participation. On days 45 and 90, balloons were hung, participants were fed, and photographs were again taken to create a celebratory atmosphere. Throughout the study, a bulletin board

---

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Tin Mill</th>
<th>Drivers</th>
<th>Warehouse</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>24</td>
<td>18</td>
<td>36</td>
<td>78</td>
</tr>
<tr>
<td>Female</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>18</td>
<td>36</td>
<td>79</td>
</tr>
<tr>
<td>Average age (years)</td>
<td>57.3</td>
<td>49.3</td>
<td>44.5</td>
<td>50.4</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Musculoskeletal Area</th>
<th>Stretch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>Lateral neck stretch</td>
</tr>
<tr>
<td>Upper back/shoulders</td>
<td>Clasped hand arm stretch</td>
</tr>
<tr>
<td></td>
<td>Upper back forward stretch</td>
</tr>
<tr>
<td>Lower back</td>
<td>Hanging crossed-arm stretch</td>
</tr>
<tr>
<td>Waist/upper torso</td>
<td>Standing waist stretch</td>
</tr>
<tr>
<td>Thighs</td>
<td>Standing quad stretch</td>
</tr>
<tr>
<td>Hamstrings</td>
<td>Standing hamstring stretch</td>
</tr>
<tr>
<td>Inner thighs</td>
<td>Inner thigh squat</td>
</tr>
<tr>
<td>Calves</td>
<td>Basic lunge</td>
</tr>
</tbody>
</table>


Table 3

<table>
<thead>
<tr>
<th>Time (Employee Group)</th>
<th>Number of Employees</th>
<th>Number of Injuries/Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1—December 2008 to March 2009 (eligible employees)</td>
<td>785</td>
<td>51/6.5%</td>
</tr>
<tr>
<td>T2—December 2009 to March 2010 (eligible employees)</td>
<td>1,248</td>
<td>106/8.5%</td>
</tr>
<tr>
<td>T2—December 2009 to March 2010 (program participants)</td>
<td>79</td>
<td>1/1.3%</td>
</tr>
</tbody>
</table>

Figure 1. Injury rates of total employees during T2 compared to program participants.

Figure 2. Injury rates of total employees during T1 compared to program participants during T2.

was maintained to update workers about the stretching program, display photographs of participants stretching, and post facts regarding the musculoskeletal system. At the conclusion of the study, participants autographed the original thank you banner to symbolize ownership and pride in their accomplishments. Each participant received a $20 gift card on study completion.

Data Collection

The outcome variables were the number of work-related musculoskeletal injuries during the stretching program, and participant compliance during the program. Baseline data related to the number of injuries, from the eligible employee population, during the 3-month period from December 2008 to March 2009 were retrospectively collected and compared to prospective data collected during the 90-day intervention period, from the eligible population and then from the program participants from December 2009 to March 2010. This procedure allowed for comparison of retrospective data collected from the same time period 1 year earlier and from the same time frame for participants and nonparticipants. The number of work-related musculoskeletal injuries for each time period was tabulated by combining employee injuries from both companies. All work-related musculoskeletal injuries, as per standing injury protocol, were recorded electronically by a third party and forwarded via e-mail to the health clinics. Participation rates were tracked using attendance logs in an Excel spreadsheet format. Daily participation of drivers and tin mill participants was self-reported on individual rosters. At the conclusion of the study, rosters were collected.

RESULTS

Outcome data consisted of injury rates and program compliance rates. For the 3-month period 1 year prior to the program (T1), 51 injuries were recorded among 785 employees—an injury rate of 6.5%. The injury rate varied slightly for each location: the tin mill injury rate was 6.5% (42 of 648) and the beverage company injury rate was 5.8% (9 of 156). At T2, eligible employees totaled 1,248; 106 injuries occurred, for an injury rate of 8.5%. Also at T2, the total number of employees completing the study was 78. Twenty-four tin mill participants completed the protocol injury-free, and 55 beverage company participants had only one injury. These results are summarized in Table 3. No employee reported any adverse events due to the stretching protocol. According to attendance records, 100% of eligible participants completed the study.

Statistical analysis was conducted by comparing two population proportions. The researchers compared eligible employee injury rates in T1 and T2, and the injury rate of program participants in T2 and the company-wide injury rate in T2. The injury rate prior to program implementation (T1) was 6.5% (51 of 785). The relative risk (T1) of non-stretchers being injured was 5.13, and the risk of injury for stretchers was 0.19. The odds of experiencing a work-related musculoskeletal injury were 5.41 times higher for non-stretchers. During the program (T2), the injury rate was 8.5% (106 of 1,248) for the eligible population and 1.3% (1 of 79) for program participants. Injury rates differed significantly between the stretching group and the eligible population during T1 (p = .03). Injury rates also differed significantly between the eligible population at T2 and those completing the stretching program (p = .01). The relative risk (T2) of incurring an injury was 6.70 for non-stretchers, compared to 0.14 for those who did stretch. The odds of experiencing a work-related musculoskeletal injury were 7.69 times higher.
Table 4
Costs and Savings for the Tin Mill

For program participants, T2
Average wage/hour = $23.00
6 minutes of stretching = $2.30/day \times 60 \text{ working days} \times 24 \text{ employees} = $3,312.00
Savings:
Number of projected injuries based on 2008-2009 figures = 1.6 or 2 injuries
2 injuries \times $3,500.00 = $7,000.00
Actual number of injuries \times 60 \text{ working days} = 0
Savings: $7,000.00 - $3,312.00 = $3,688.00
Based on 1 employee for 1 year
Average wage/hour = $23.00
6 minutes of stretching = $2.30/day \times 250 \text{ working days/year} = $575.00
Cost of 1 nonsurgical injury = $3,500.00
Savings: $3,500.00 - $575.00 = $2,925.00/year without injury/employee

Table 5
Costs and Savings for the Beverage Company

Warehouse employees only, T2
Average wage/hour = $19.00
6 minutes of stretching = $1.90/day \times 60 \text{ working days} \times 37 \text{ employees} = $4,218.00
Savings:
Number of projected injuries based on 2008-2009 figures = 3.17 or 3 injuries
3 injuries \times $3,900.00 = $11,700.00
Actual number of injuries \times 60 \text{ working days} = 0
Savings: $11,700.00 - $4,218.00 = $7,482.00
Based on 1 employee for 1 year
Average wage/hour = $19.00
6 minutes of stretching = $1.90/day \times 250 \text{ working days} \times 1 \text{ employee} = $475.00
Cost of 1 nonsurgical injury = $3,900.00
Savings: $3,900.00 - $475.00 = $3,425.00/year without injury/employee

Note. Drivers were not included in these calculations due to their being salaried employees.

for non-stretchers than for those who participated in the stretching program during T2 (Figs. 1 and 2).
Modest resources were needed to develop and implement this program. The largest cost was employee time during daily stretching. Information used for costs and saving calculations derived from internal company data (Tables 4 and 5).

DISCUSSION
Interpretation of Results
This pilot project described the effects of a pre-shift stretching routine on work-related musculoskeletal injuries among laborers in a tin mill and a beverage company.

The study investigated injury prevention using a proactive approach. This stretching program had statistically significant results despite its relatively small sample size. Similar studies have been published (da Costa, 2008; Hess & Hecker, 2003; Yeung & Yeung, 2001) with inconclusive results. The injury rates of program participants were compared to the injury rate for the eligible population 1 year prior (T1) and the injury rate for all eligible employees during the stretching program (T2). During T2, the injury rate increased over T1, yet those involved in the stretching program remained insulated from injury.

A second aim of this study was to determine participant compliance with the stretching program. Attendance...
sheets indicated 100% participation and 100% program completion, indicating strong participant commitment.

Cost savings to both industries were studied using two time periods: the savings during the 3-month intervention and the savings projected for a full year for one employee. Tin mill savings during the 3-month intervention, considering the cost of 24 workers participating, equaled $3,688.00; the savings for one injury-free employee for a year was $2,925.00. The beverage company had similar savings. During the intervention, a savings of $7,482.00 was realized for 37 warehouse workers; the savings for one injury-free employee for 1 year was estimated at $3,425.00. Drivers were not included in the cost analysis because their earned commissions resulted in difficulty computing their hourly wage.

Study Limitations

Study limitations may have affected internal and external validity. Implementation of the program may have sensitized participants to personal responsibility for injury prevention, possibly affecting injury rates. Prompts such as bulletin board information, meals, and periodic celebrations may have served as safety reminders, raising awareness and decreasing injuries. Workloads varied from year to year, despite time frame comparisons. The sample of workers at T2 may not have been reflective of the population at T1 as a result of changes in the work force and maturation of the population; therefore, a second analysis was completed comparing injuries of all eligible employees at T2 to injuries of program participants. Weather, road conditions, and equipment condition may also play a role in injury risk from year to year. The Hawthorne effect and the monetary incentive may have contributed to participants’ completing the study. Selection bias may have also played a role in the results, as participation was voluntary. Attrition played a role when 16 participants were voluntarily laid off based on seniority. Only one female participated in the study. The small, convenience sample may not have been representative of the average worker, limiting the generalizability of study results. Drivers were responsible for tracking their daily stretching participation; this self-report process may not have been reliable.

Implications and Applications

Much work requires manual labor, increasing employees’ risk for injury. In the current project, a decrease in participants’ injuries occurred during the 90-day stretching program, compared to among program-eligible employees during T1 and T2. This finding suggests that even a brief stretching protocol, requiring little time and resources, can positively impact work-related injuries among laborers working under similar circumstances.

One hundred percent of the eligible participants completed the study. This incredible participation may be a result of the investigators accurately and completely divulging the purpose of the study and expectations of participants prior to study initiation. The high completion rate may have also been influenced by the gift card incentive. Demonstrating participant appreciation by offering food, public acknowledgment, and a positive work environment may have encouraged program compliance.

The cost savings analysis completed for each location demonstrated substantial savings despite employees using company time to stretch. Other companies looking to reduce injuries inexpensively may want to consider a similar daily pre-shift stretching program. Results from this pilot may encourage further investigation.

Following the completion of this study, the beverage company and the tin mill continued the stretching program, on company time, for interested employees at both sites. Both companies are expanding the stretching program to other locations.

CONCLUSION

The project suggests that a brief, inexpensive stretching protocol is feasible in a manual labor environment and associated with short-term positive results. In addition, this study demonstrated that volunteer participants could remain committed to a stretching program that they reported was well designed and offered physical benefits. Additional studies, with larger sample sizes and longitudinal designs, could address the types of employees who benefit most from stretching and timing and type of exercises most beneficial and resulting in substantial decreases in overall costs.

REFERENCES


