EXERCISE AS A PROPHYLACTIC DEVICE AGAINST CARPAL TUNNEL SYNDROME*

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ABSTRACT

The null hupothesis that participation in an on-the-job strength and flexibility exercise program typical of those directed toward prevention of musculoskeletal stress has no prophylactic effect against carpal tunnel syndrome when used as an intervention measure in a population of female garment workers was examined. Grip strength, Phelan's test results, and hand/wrist thermograms obtained by liquid crystal thermography were taken on an experimental group of female employees in a southern garment manufacturing facility before, after five weeks, and after ten weeks of an exercise program and compared with data obtained from a control group. Although the test results suggested the exercise program may have had some benefit, the null hypothesis could not be rejected. An engineering economic analysis, assuming the exercise program was effective and implemented throughout the corporation, indicated the payback period would be approximately eleven years thus casting doubt on its economic efficacy also.

INTRODUCTION

Objectives

The primary objective of this research was to investigate the null hypothesis that participation in an on-the-job strength and flexibility exercise program typical of those intended to counter musculoskeletal stress has no prophylactic effect against carpal tunnel syndrome when used as an intervention measure in a population of female garment workers. A secondary objective was to investigate the economic implications of implementing an exercise program in a garment production company.

Perspective

The possibility of a positive relationship between reduction in the incidence of clinical symptoms of carpal tunnel syndrome (CTS) or other cronic musculoskeletal disorders and various exercises has been discussed by several authors. Examples include Lutz and Hansford (1987), Sawyer (1987), and Silverstein, et al.(1988). Typical exercise programs include both flexibility and strengthening activities. It is postulated the flexibility exercises make the muscles more flexible and supple thereby reducing the risk of musculoskeletal problems. Strengthening exercises are credited with increasing blood flow and the general resistance of the body to degradation by repeated stress. Previous evaluations of such exercise programs typically report they are positively received by the employees (Sawyer, 1987; Silverstein, et al., 1988), but those claiming reduction in cumulative trauma disorders (Lutz and Hansford, 1987; Sawyer, 1987) have been confounded by concomitant task redesign or other job changes.

The economic impact of work related general health promotion exercise programs has been recently reviewed by Shephard (1989), leading to the conclusion they are likely cost effective when intangibles such as employee morale and company reputation are taken into account. They may not be justified purely on the basis of cost containment however.

The present study sought to evaluate both the physical and economic effects of an exercise program which was being introduced on an experimental basis into a garment production facility. The program was designed with specific emphasis upon carpal tunnel syndrome as that disorder is relatively prevalent in the industry. The work situation did not involve ongoing job redesign activities.

*This research was supported in part by an ERC training grant from NIOSH

**The information presented does not necessarily reflect the opinions of the Air Force Institute of Technology, Air University, or the U.S. Air Force.

METHOD

Subjects

Employees in two distinct but similar production centers in one plant of a multi-plant garment production company served as subjects for this study. The specific plant and subject groups were selected by corporate occupational safety and health personnel. The plant was one of the company's more modern facilities with state of the art sewing and processing equipment. The plant employed a total of 532 workers and had a general athletic apparel product line. The work centers participating in this research were performing sewing operations on fleece sweat shirts at the time of data collection.

Thirty employees, all female, served as subjects for the research. Fourteen employees (work center 21) served as the experimental group. Sixteen individuals (work center 49) served as a control group. The average age and years of employment with the company for the W.C. 21 employees was 35.1 and 8.4 years respectively. For W.C. 49 these averages were 28.3 and 5.7 years. The fact that the control group was somewhat younger and less experienced than the experiment group was not a cause of concern since all subjects were pre-menopausal and thus not subject to hormonal changes that might have influenced the experimental outcome.

Exercises

Work center 21 employees performed seven flexibility and three strength enhancing exercises selected by company occupational safety and health personnel based upon the recommendations of a physical therapist. The exercises were similar to those reported by other investigators (Sawyer, 1987); a descriptive name for each exercise and the number of repetitions performed are presented in table 1. The exercises were performed in the morning and again in the afternoon immediately prior to the regularly scheduled breaks. The total time required per exercise session was approximately ten minutes at the beginning of the experimental program. This reduced to eight minutes as the subjects become completely familiar with the exercise routine.

Table 1. Exercises

Descriptive Name	Repetitions
Flexibility Exercises	
Ceiling Stretch	5 for count of 5
Head Tilts	5 left then 5 rt.
Arm Circles	10 forward then 10 backward
Shoulder Shrugs and Presses	5 for count of 5
Arm Crosses and Elbow Touches	5 for count of 5
Finger Stretches	5 for count of 5
Wrist Stretches	5 for count of 5
Strength (Nerf Ball) Exercises	
Thumb Presses	30 each hand
Finger Squeezes	30 each hand
Whole Hand Squeeze	30 each hand

Tests Conducted

A variety of evaluation techniques have been used as indicators of median nerve disfunction. These may be catagorized as to the type of nerve function being tested: motor, sensory, or autonomic (Merritt, 1987). One test from each catagory was chosen for use as an indicator of the subject's state of hand/wrist "health". Motor function was evaluated by a grip strength test, sensory function was evaluated by Phalen's test, and autonomic function was appraised via. liquid crystal thermography.

A hand dynamometer was used to test grip strength. This test is based upon the fact that if the nerve supply to a muscle is interrupted, the muscle will atrophy, tonus will decrease, and the muscle will thus be weakened (Phalen, 1972). With the arm extended and hanging naturally at her side, the employee grasped the dynamometer and performed a three second maximum voluntary squeeze. The maximum exertion was recorded for both hands. Lacking any specific guidance from the literature, a change in grip strength of 15% between initial and final testing was considered as a "significant" change.

Phalen's test has been widely used in the clinical diagnosis of carpal

tunnel syndrome (Phalen, 1972; Senor, 1988). The test involves unforced, complete flexion of the wrist for a period of 30 to 60 seconds. The hands are placed back to back with the finger tips pointing down and elbows held parallel to the floor. A positive test is recorded if extreme tingling (to the point of pain) is reported by the subject.

Liquid crystal thermography (LCT) is used as a diagnostic tool to identify different thermal gradients on the surface of the item tested. When applied to the hands and wrists, LCT provides an indication of circulation restriction as a result of nerve disfunction. Herrick among others has found LCT to be a useful tool in orthopedic practice in the early diagnosis of carpal tunnel syndrome (Herrick, et al., 1986).

The methodology for the LCT testing was based on procedures published by Flexitherm, Inc. (1982). A minimum of three thermograms were obtained for each of two hand positions and of the wrist. The thermograms were recorded using a Polaroid camera. Thermograms of the hands (pronated and supinated) and the anterior portions of the wrists of each subject were compared intra-employee for variances in general trends of heating. If the thermal gradients of the hands or wrists in the areas innervated by the median nerve were not symmetrical, a positive test result was recorded.

The thermograms were divided into three groups: "definitely positive", "definitely negative", and "cannot confirm". At least two consistent thermograms were required to confirm placement of a subject into the positive or negative group. If the thermogram images were equivocal for any reason, then the subject was placed into the third catagory. The thermograms were evaluated by the principal author and the results discussed for confirmation with the third author who is highly experienced in the clinical use of LCT.

Data Collection

On 6 October 1988, company safety and health personnel and the principal author met with the involved employees. The subjects were told data was being collected to determine the effects of exercise on wrist circulation and grip strength. The exercises were demonstrated and the general testing procedures described.

Pre-exercise, or baseline, data were obtained on October 10 and 11. On 17 November, five weeks after start of the exercise program, mid-experiment testing was performed on six employees randomly selected from each of the two subject groups. Only a total of twelve employees were tested at mid-term due to company concern for the subjects lost production time and the costs associated with the LCT data collection. On 19 and 20 December, ten weeks after start of the exercise program, final data collection was performed.

RESULTS

Exercise Program

The best indicator that the exercise program could serve as a prophylactic device against the physiological effects of carpal tunnel syndrome would be results that could be classifed into the following situation: subjects who upon initial examination appeared symptomatic based upon the Phalen's and LCT results tested asymptomic by the end of the exercise program and experienced an increase in grip strength. Secondary, but less clear, indicators of exercise having positive effects would be (1) an increase in grip strength only, especially in subjects whose initial test results suggested carpal tunnel symptoms, or (2), reversal from positive to negative Phalen's and/or LCT test results between the initial and final testing with no accompanying increase in grip strength. Similar findings for the non-exercising control group or findings opposite to those described (i.e., asymptomatic subjects changing to symptomatic by the end of the exercise program) would suggest the exercises were not beneficial.

Upon initial testing, only one WC 21 employee tested positive for CTS based on Phalen's test and none were so classified by the LCT results although three subjects gave results that appeared highly probable of being positive. Test results for the six randomly selected employees after five weeks of exercise was consistent with

the inital testing; however, the one individual who had tested positive was not among the six randomly selected. Upon final testing, the employee who had initially been symptomatic appeared asymptomatic and had an increase in grip strength of more than 15%. In addition, one of the three subjects with initial questionable LCT results had a greater than 15% increase in grip strength and a negative thermogram for the hand originally questionable. On the contrary, the LCT results showed that a subject who had not initially appeared symptomatic tested positive at the end of the exercise program and four subjects appeared possibly positive including two of the three who appeared questionable upon initial testing. Changes in grip strength for these employees was not consistent with the hypothesis that exercise was beneficial.

Upon initial testing, two WC 49 employees appeared CTS symptomatic; one based on Phalan's test, the other on LCT. Two others appeared possibly symptomatic in their dominant hand based on the thermograms. At the completion of the ten week period, none of the WC 49 subjects tested positive based on Phalan's test, and three (including the two indicated by the initial testing) appeared potentially positive based on the LCT data. The result for the two subjects who initially tested positive was equivocal, however, as the final test results implicated their recessive rather than dominant hands. Nine WC 49 employees experienced greater than 15% increases in grip strength. This was not expected since the WC 49 employees did not exercise.

The exercise program appeared to have a mixed psycho-social impact upon WC 21 employees. Most subjects were interviewed after the completion of the ten week program and each stated she felt better after exercising which agrees with findings in other studies. On the other hand, all but one disliked the timing of the exercises claiming they interfered with their productivity and thus their opportunity to earn incentive wages.

Economic Analysis

The company's industrial engineering department computed the cost that would be associated with the exercise program if it were implemented in all 15 of the company's apparel facilities. The cost estimate included out of pocket labor expense, unabsorbed overhead, and lost profit on items not produced due to time being expended on exercise. The costs of exercising on "company time" (during the normal eight hour work day) and after the normal work day were both estimated. The cost estimate assumed a 30 minute preliminary meeting with employees to explain the program, 20 minutes devoted to exercising per day for three weeks, and 10 minutes per day for the long term.

The total cost of a "company time" program was estimated to be $5,626,000 annually; the cost of the "after hours" program was estimated at $2,154,000. The company engineers made no analysis of net costs assuming some reasonable expected reduction in worker's compensation costs would result from the exercise program. The principal author performed such an analysis however, and determined that it would take approximately eleven years for the exercise program to break-even.

CONCLUSIONS

The scope of this research was too limited to permit any strong statment relative to the efficacy of an exercise program. One of the 14 exercising employees clearly appeared to have benefited from the program and another may have. Others in that group seemed to have received no or perhaps negative effects. Similarly, members of the control group experienced changes in their symptomatic state which were inconsistent with a finding that an exercise program would provide significant benefit. Thus the null hypothesis could not be rejected. The data were evaluated in a "conservative" manner, however, and it is possible that exercise may serve, at least partially, as a prophylactic device against the physiological effects of CTS.

The economic analyses, although based on numerous assumptions, suggests that exercise programs likely result in significant expenditures when compared to the potential cost savings that may result. Activities with pay-back periods on the order of eleven years are usually

considered poor alternatives for investment assuming only economic considerations.

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