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COLLEGE OF MANAGEMENT AND TECHNOLOGY

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Terrance Knox

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Walden University
2010

ABSTRACT

Manual Handling Workload and Musculoskeletal Discomfort among Warehouse Personnel

by

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Engineering Technology, Nielsen Electronics Institute, 1988
B.S., DeVry University, 1999
M.B.A., American InterContinental University, 2003

Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

Walden University
August 2010

ABSTRACT

Work-related musculoskeletal disorders (WRMSD), specifically physical and muscular discomfort in the upper arm, lower arm, thigh, lower leg, wrist, shoulders, back, or neck, are among the most frequently reported workplace injuries in the United States. The dearth of knowledge about the types of workloads that may contribute to the development of WRMSD was the impetus of this research. The study aimed to identify antecedents of WRMSD among warehouse workers in order to reduce WRMSDs and increase productivity as expressed in a systems perspective on industrial health. The research questions examined the prevalence of specific WRMSDs, the relationship of high-risk tasks of warehouse personnel with WRMSD incidence, and the relationship of job category and workload with WRMSD incidence. The sample included 82 warehouse workers, stockroom clerks, and forklift drivers. MANOVA was used as the data analysis technique. The results showed that WRMSD was the most prevalent in the upper back, lower back, knees, and lower legs. Various high-risk tasks were linked to WRMSD incidence including repeatedly bending to lift objects was associated with discomfort in the lower back, shoulders, and lower legs. Furthermore, the use of pallets led to reduced discomfort and work interference in the hips and buttocks, upper arms, and knees. Proper lifting form may reduce WRMSD in the shoulders, forearms, lower back, and wrists in particular. The social change implications of this study stem from the notion that increasing the employers' WRMSD prevention awareness will lead to an increase in safety attentiveness and decrease workers' injuries.

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CHAPTER 1: INTRODUCTION TO THE STUDY

Introduction

Work-related Musculoskeletal disorders (WRMSDs) are among the most highly reported workplace injuries in the United States (Bridger, 2003). WRMSDs injuries that affect the body's connective tissues, namely, muscles, nerves, tendons, joints, cartilage, or spinal disc (U.S. Bureau of Labor Statistics, 2009). In 2007, MSDs were responsible for 29% of all work-related injuries. On average, individuals with an MSD missed a total of 9 days of work annually. Sprains and strains are the most frequently reported conditions and cases involving the back comprise 33% of such injuries (U.S. Bureau of Labor Statistics, 2009). MSDs cause significant stress on employees and employers.

Individuals, when injured on the job, are entitled to Workers' Compensation payments (Daltroy et al., 2007). Workers' Compensation is insurance paid for by the employer to provide cash benefits and medical care for the disabled. Workers' Compensation legislation covers all employees. MSDs are responsible for up to 40% of compensation claims (Daltroy et al., 2007). MSDs can create significant financial liabilities for employers.

The challenge of management is to incorporate ways to prevent work-related injuries in the workplace. Over the long term, it will cost employers more money not to implement programs that prevent employee job injuries (MacLeod, 2005). With the rising cost of health premiums and increased time away from work because of work-related injuries, it would be wise of management to incorporate contingency plans to prevent unnecessary injuries among workers (MacLeod, 2005). Higginson (2008) asserted, "The

Health and Safety Executive estimates we lose 36 million days each year to work-related illness. This costs companies $533 per year per employee. The Chartered Institute of Personnel and Development puts this figure even higher at $666" (p. 24). Based on these figures, work-related injuries should be high on management's agenda to provide interventions that will reduce them.

The prevalence of MSDs varies, depending on the industry (U.S. Bureau of Labor Statistics, 2009). For example, workers in the mining industry miss the most days from work on an annual basis. Sanders (2004) suggested that workload contributes to MSDs, particularly in industries that have a high risk of bodily injuries. The industries with the highest incidence rate are those in which the primary job responsibilities entail manual labor, such as freight, stock, and material movers (U.S. Bureau of Labor Statistics, 2009).

Despite the negative impact of MSDs on employees and the significant financial burden on employers because of compensation claims, there has been a lack of research investigating the relationship between performing physically demanding tasks, the incidence of injury, and subsequent Workers' Compensation claims from the workers' perspective. According to Bryant (2005), empirical investigations of this nature have been lacking in current MSD and compensation-related literature. As such, the current study sought to inform this line of inquiry to promote positive change in the area of concern regarding work-related musculoskeletal disorders (WRMSDs).

Statement of the Problem

WRMSDs are among the most frequently reported workplace injuries in the United States. Meinhardt (2006) contended that "musculoskeletal disorders account for $1 of every $3 spent on Workers Compensation [WC] in America and affect 1.8 million workers each year" (p. 1). Workload contributes to WRMSDs, particularly in industries that require workers to perform work that is repetitive and involves bending, sloping over, and constant lifting (Fragala, 2006). The research is limited regarding the frequency of WRMSDs and workload types that may contribute to the development of WRMSDs (Snook & Webster, 2007). The current study sought to inform this knowledge gap by investigating the physiological effects of performing high-risk physical tasks by a select group of warehouse workers. This investigation included other risk factors that may be associated with WRMSDs, and identified any secondary factors that may contribute to the link between frequency and high-risk physical tasks. Additionally, this study examined the variability of workload by job category. Although this study investigated whether manual handling workload frequencies vary by job position, it did not analyze the biomechanics regarding high physical workload that causes WRMSDs. There has been a wealth of research on the biomechanics involved in the development of WRMSDs, and such research was outside the scope of this study.

Purpose of the Study

This study investigated the association between the frequency of WRMSDs among able-bodied warehouse personnel and the factors hypothesized to be associated with this discomfort, such as the performance of manual handling tasks. Other risk

factors were examined to determine whether any secondary factors are related to the relationship between the frequency of performing high-risk tasks and the development of WRMSDs. In addition, the study sought to increase employers' awareness of methods that prevent WRMSDs by providing pre and post training to decrease workers' injuries and increase the safety of the workplace environment. By doing so, the researcher hypothesized that the decrease in workers' injuries and the increase in safety will contribute to higher productivity. Finally, this study identified the major concerns of WRMSDs and provided solutions for a safer and more efficient workplace. It is hopeful that public policy will use the findings regarding the visibility of WRMSDs.

The study employed a quantitative, non-experimental, comparative, correlational research design to identify an association between the frequency and severity of WRMSDs among able-bodied warehouse personnel. The study was conducted in Atlanta, Georgia, and the sample comprised 71 warehouse workers, stockroom clerks, and forklift drivers. The researcher had access to five warehouses in Atlanta; therefore, participants were selected using convenience sampling. The survey format collected demographic and other data specifically related to WRMSDs. The SPSS 16 computer program analyzed the data. Descriptive statistic and correlations between the variables were determined.

Theoretical Framework

Systems theory provided the theoretical framework for the entire study, including the methods of inquiry and analysis. To understand the relationship between machine systems and ergonomics, it is necessary to describe a system in terms of what it does and how it works. According to Bridger (2003),

> A system can be defined as a bounded set of related objects, brought together for a specific purpose, which transcends any of the constituent parts in isolation. Systems have a hierarchical structure, and systems design and analysis have to take structure into account, Because system are more than the sum of their parts, systems design cannot be optimized solely from the bottom up. Real systems are dynamic and interact with their environments at different levels of complexity. (p. 453)

LittleJohn (1983) identified six major issues about system theory. A description of each follows:

1. Does the breadth and generality of a system theory provide the advantage of integration or disadvantage or the disadvantage of ambiguity? Supporters of systems theory claim that the advantage of the theory is that it provides a common vocabulary in which to provide integration of the sciences and established logic to apply across a broad range of phenomena. However, others believe that systems theory is merely confusing. Delia, asserted system theory as manifesting an ambiguity which at times presents a "substantive perspective making specific theoretical claims and at other points present a general abstract language devoid of specific theoretical substance" (as cited in LittleJohn, 1983, p. 17).
2. Does the theory's openness provide flexibility in application? This concern relates to the concept of the appropriateness of the theory. In other words, two theories utilizing a system framework may contradict each other.
3. Is system theory merely a philosophical perspective, or does it provide an explanation? Some critics will not call it a theory, as they claim it lacks explanatory power.

4. Has system theory generated useful research? This issue questions the ability of system theory to generate research. In other words, due to the extreme generality of this approach, the theory does not suggest substantive questions for investigation.
5. Is the system paradigm an arbitrary convention, or does it reflect reality in nature? This issue relates to the validity of system theory and whether or not the theory reflects what actually takes place in nature or that it is merely a useful means of explaining complex processes.
6. Does system theory simplify or complicate issues more than necessary? This final issue is concerned with the allegation of critics that systems theory tends to overcomplicate simple events.

The systems approach was appropriate for this study because system thinkers must be able to shift between analytic and synthetic modes and describe system behavior at different levels of analysis. One could apply this thought process to human factors and ergonomics because ergonomists assess the ways in which the indices have affected the overall functioning of the system. Dwyer and Raffery (as cited in Bridger, 2003) identified many other factors related to systems functioning in industrial health:

1. Employee malnutrition.
2. Extended work hours.
3. Absence of integration of different work groups.

In their investigation of industrial accidents, Dwyer and Raffery concluded that accidents could be prevented by a system in which workers exercised greater automatic control of

their activities and in which management initiates, in the absence of conditions favorable to auto control, a proper safety management program (p. 455).

Background of the Study

Research on WRMSDs and back injuries, particularly studies related to the construction and nursing industrial industries, has focused on identifying the risks of developing WRMSDs in relationship to the physical factors, organizational factors, social context, and individual factors that affect the load relationship as well as subsequent responses to injuries (Sanders, 2004). DeJong, Garzarian, and Cibukskisk (2003) evaluated the adoption of interventions and perceptions of workload and work methods in bricklaying. DeJong et al. found that the bricklayers and other workers could have achieved changes in workplace practices more easily with more participation.

The factors that cause WRMSDs are interdependent and complex.(Bridger,2003). For example, physical workload may be a factor if workload is increased. A workload increase may mean that workers have an increased likelihood of developing WRMSDs. .(Bridger, 2003). However, the workload may affect individuals differently based on their tolerance for pain, so not all individuals will develop WRMSDs.

Organizational factors that may contribute to WRMSDs include the dynamics of political issues, that is, whether the organization decides to take proactive steps to reduce work-related injuries or ignore the problems because of costs or other reasons. In addition, physiological factors may contribute to the development of WRMSDs. For example, physiologic responses indicate the stress or anxiety level of workers based on the everyday demands of their jobs. (Sanders, 2004). Upon identification of these

physiologic responses, workers can inform their employers, who can then document the information as injury reports. (Sanders, 2004). Once identified, medical staff should assess these injuries to determine if the employees are eligible for disability. (Sanders, 2004). The intent of the social content of the organization is to create a positive working environment for employees and reduce injuries. (Sanders, 2004). If the organizational culture is more concerned with productivity than safety, it is more likely that more injuries will occur.

If the work environment involves performing physical tasks that requires heavy lifting, it is likely that workers will experience signs of WRMSDs. In assessing the WRMSD the physical (i.e., biomechanical) factors associated with work at the individual level do not represent the full spectrum of possible risks. (Sanders, 2004). The macro- and organizational levels of risk underlie not only physical but also psychosocial job characteristics, both of which are determined in a large part by the way that work is organized. (Sanders, 2004). One possible solution that may minimize or prevent these symptoms is the organization's implementation of programs that include interventions to prevent injuries to its workers. As part of intervention programs, injury reports are required to identify the types of injury and prevent them from reoccurring. (Sanders, 2004). Proper documentation will help to identify the specific problems to address through corrective action (MacLeod, 2005).

Nature of the Study

The researcher employed a quantitative, non-experimental, comparative, correlational research design that facilitated the comparison of two continuous (interval or ratio level) variables to determine whether there was an association between them. Predictor variables included high-risk and handling tasks of warehouse personnel and WRMSD symptoms were the outcome variables.

This study investigated the association between the frequency of WRMSDs among able-bodied warehouse personnel and the factors hypothesized to be associated with this discomfort, such as the performance of manual handling tasks. Frequencies and percentages of the data, were analyzed, as well as means and standard deviations, where appropriate, for gender, years of experience, usual shift, job category, and other variables. Pearson's correlation coefficient analysis identified significant bivariate associations between two variables. The correlation coefficients indicated the strength and direction of the relationship between the variables. The observational and interview data triangulated with the quantitative data, for clearer results. An ANOVA determined whether there were differences among warehouse workers, stockroom clerks, and forklift drivers regarding the number of at-risk handling tasks performed.

The quantitative, non-experimental, comparative correlational design was appropriate for this study, whose objective was to determine whether there was a relationship between the frequency of WRMSD symptoms among warehouse personnel and the frequency of high-risk and handling tasks that the workers performed, as well as between the at-risk task rating and the frequency of WRMSDs among warehouse

personnel. Because the aim was to determine whether there was a relationship between or among two or more variables, a quantitative design was more appropriate than a qualitative design, which would not have allowed the researcher to assess a direct relationship between two variables because of the open-ended questions.

Significance of the Study

This research is significant because it provides insight into the relationship between the performance of high-risk tasks and other risk factors and the frequency of WRMSDs. The study identified correlations between employee position and workload frequencies, and specific body part usage and WRMSDs. The results are significant in that they will increase employers' awareness of methods that prevent WRMSDs, such as by providing pre- and posttraining that decreases workers' injuries and ensures more safety, both of which should contribute to higher workplace productivity.

Limitations and Delimitations of the Study

I examined only the physical risk factors for WRMSDs in warehouse personnel. This study did not assess the influence of psychosocial factors, thought by some researchers to act synergistically with heavy workload to produce WRMSDs. In addition, it was limited because it did not examine the specific physiological ways in which WRMSDs are developed.

The responses of the employees to the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ, 2009) also limited this study. The specifically designed CMDQ, a questionnaire developed at Cornell University, assessed MSDs in employees. It was constructed based on previous empirical investigations of MSDs. Scores on the

questionnaire are analyzed to determine whether the individuals have postural problems. The study was dependent on the truthfulness and honesty of the responses of the warehouse employees.

The primary limitation of the study was that the use of a convenience sample in which participants were volunteers. The reliance on volunteers could have introduced bias because the individuals who chose to participate may have done so because they had an interest in the study. As such, it could possibly have had an effect on the results. Furthermore, it also could have meant that the individuals who volunteered to participate had strong emotions or opinions about the topic of interest.

Another limitation was that the study relied primarily on self-report. Individuals are subject to cognitive errors such as hindsight bias and counterfactual thinking, both of which could have been demonstrated in the study. Individuals make cognitive errors when engaging in self-report, and these cognitive errors could have exerted an influence on the research results. (Sanders, 2004). An additional limitation was the small sample size, which chould have limited the generalizability of the findings.

Assumptions of the Study

The primary assumption was that examining and exploring the relationship between high-risk behavior and the frequency of WRMSDs would yield valuable information that would increase safety and worker productivity. Another key assumption was that the participants would answer the survey questions truthfully. The sampling method for this study was one of convenience, so the researcher assumed that the sample was sufficiently representative of the target population.

In addition, all of the participants were familiar with and understood the technical terminology used within the survey. The survey instruments were appropriate mechanisms to elicit the responses necessary to provide accurate data results. The obtained results were enough to achieve adequate interpretation and survey validity. Lastly, each respondent's identity remained confidential.

Impact of WRMSDs

Back injuries are among the most highly reported WRMSDs in the United States. The medical, economic, and social costs of WRMSDs, or ergonomic injuries in the health care and industrial environments, are much higher than those costs in private industry. The most recent U.S. Department of Labor statistics (as cited in Fragala, 2005) indicated that nursing aides, orderlies, attendants, truck drivers, industrial workers, and construction laborers accounted for one of every five WRMSDs reported nationally in 1993. The American Hospital Association (as cited in Fragala, 2005) stated that WRMSDs account for the largest proportion of Workers' Compensation costs in hospitals and long-term nursing home facilities nationwide. In addition, the American Nurses Association "reported that ergonomic injuries occur in nurses at a rate that is twice as high as the general working population" (as cited in Meinhardt, 2006, p. 1). Chandra, Bush, Frank, Zachary, and Barrett (2004) asserted:

> On an average day in the United States, 9000 employees sustain disabling injuries at work, 17 workers because of a workplace injury, and 137 workers from work-related illnesses according to the Center for Disease Control and Prevention (CDC) in 2001. More specifically, a worker is injured every 5 seconds, and every 10 seconds, an employee is temporally or permanently disabled. (p. 33)

In recent years, there has been much concern about the rising premiums paid by employers for Workers' Compensation insurance and possible overuse of the system by employees. Perhaps one of the reasons for the rising premiums is the number of processed fraudulent claims. Organizations are now taking a more proactive role to eliminate fraudulent filing by employees by hiring physicians and medical staff to examine claimants thoroughly before rewarding Workers' Compensation benefits. (Fragala, 2005). The system sometimes penalized some employees, who suffer from some type of WRMSD, due to other employees who have used the system for personal gain. (Fragala, 2005). The system may need to reinforce new laws that would make it more difficult for individuals to abuse the system.

Daltroy, et al., (2007) asserted that penalizing employees because their employers do not provide safe working conditions is unmerited. In addition, there is a need for an increase in interventions and Workers' Compensation insurance benefits to employees so that they can get adequate care and reduce the time away from work (Daltroy et al., 2007). However, because the prevention of all WRMSDs is limited, there is no easy answer. Efforts should target at reducing the likelihood of injury in the workplace to decrease Workers' Compensation claims and time away from work. The study may contribute by identifying the factors related to a reduction of WRMSDs and increased worker productivity.

WRMSDs usually have financial repercussions for employees and employers (Snook & Webster, 2007). Although it often is difficult to assess the pain and suffering of individual workers, the cost of disabling injury has roughly doubled since 1986,

according to the National Safety Council (1986, as cited in Fragala, 2005). Estimates by the Institute of Medicine (2001) showed that in 1999, nearly 1 million individuals missed work because of WRMSDs. Because WRMSDs are becoming more prevalent, it is important that employers offer Workers' Compensation to their employees to pay medical expenses and compensate them for pain, suffering, and time away from work. The purpose of Workers' Compensation is to pay medical costs and lost wages to workers who are injured or made ill while on the job (Fragala, 2005).

Guo, Tankaka, William and Lorraine (1999) analyzed data from the 1988 National Health Interview Survey, to identify high-risk industries and to estimate the prevalence of work-related back pain and number of workdays lost. The findings indicated that males aged 25 to 34 and females aged 65 to 74 had the largest proportion of lost workday cases. In addition, Whites had the largest number of Workers' Compensation claims in comparison to other races.

Research Questions and Hypotheses

The following research questions and hypothesis guided this study:

1. How does the frequency of high-risk and handling tasks of warehouse personnel relate to WRMSD symptoms?
2. How are workload and WRMSDs different by job category among warehouse personnel (warehouse workers, stockroom clerks, and forklift drivers)?
3. What is the nature of the relationship between the at-risk classification rating and the frequency of WRMSDs among warehouse personnel?

Hypothesis 1

H_0: There is no relationship between the frequency of WRMSD symptoms in warehouse personnel and the frequency of high-risk and handling tasks that the workers perform.

H_a: There is a positive relationship between the frequency of WRMSD symptoms in warehouse personnel and the frequency of high-risk and handling tasks that the workers perform.

Hypothesis 2

H_0: There is no difference in the number of at-risk handling tasks performed by warehouse workers, stockroom clerks, and forklift drivers.

H_a: There is a significant difference in the number of at-risk handling tasks performed by warehouse workers, stockroom clerks, and forklift drivers.

Hypothesis 3

H_0: There is no relationship between the at-risk task rating and the frequency of WRMSDs among warehouse personnel**.**

H_a: There is a relationship between the at-risk task rating and the frequency of WRMSDs among warehouse personnel**.**

Definitions of Terms

Balance theory of job design: This work system is responsible for creating physiological and psychological burdens on individuals that may result in physical, psychological, or biological consequences (Smith & Carayon-Sainfort, 2005).

Biomechanics: The science concerned with the effect of internal and external forces on the human body (Institute of Medicine, 2001).

Cumulative trauma model: This model assumes that injury results from the accumulated effects of workloads that by themselves may not create damage. However, after repeated cumulative exposure, such workloads may result in injury (Institute of Medicine, 2001).

Ergonomics: The study of the interaction between people and machines and the factors that affect the interaction. Its purpose is to improve the performance of systems by improving human machine interaction" (Bridger, 2003, p. 2). Discipline involves arranging the environment to accommodate the needs of the person.

Ergonomic injury: This type of injury or illness affects the connective tissues of the body, including muscles, nerves, tendons, joints, cartilage, or spinal discs (U.S. Bureau of Labor Statistics, 2009).

High risk: These task(s) on the job are usually high risk and the reason for some MSD symptoms that may cause injuries to the back, arms, legs, and so on. One example is repetitive tasks or constant lifting (Salvendy, 2007, p. 543).

Job-risk factors: These risk factors are associated with injury due to improper performance of tasks or a lack of safety intervention(s) to prevent injury (Salvendy, 2007, p.579).

Kinematics: Kinematics is a branch of biomechanics concerned with the study of movement, that is, the amount of time to carry out the activity (Institute of Medicine, 2001).

Low-back pain: Pain in the low back area, excluding menstrual cramps and/or leg fatigue unassociated with low back pain" (Cato, Olsen, & Studer, 1989, p. 322).

Manual handling workload: This activity involves the pushing, pulling, lifting, and/or carrying of some weighted material (Salvendy, 2007, p.644).

Musculoskeletal disorders: Mismatch between physical capacities and the physical demands of the job (Sanders, 2004).

Overexertion: Overexertion happens when the musculoskeletal system has to perform beyond its capacity (Sanders, 2004).

Posture: "If a worker is in unbalanced seated or standing position, an inadvertent step into a floor switch or a reach into danger zone to catch oneself while falling are potential factors in injury causation" (Salvendy, 2007, p. 873).

Standing aids: These aids include equipment or tools used to aid workers who are required to stand while working (Sanders,2004).

Warehouse personnel: Workers employed in an industrial setting and perform various job tasks in a warehouse environment include equipment operators, forklift operators, and stockroom clerks (Salvendy, 2007).

Workers' Compensation: Workers' Compensation insurance is paid for by employers and provides cash benefits and medical care if workers become disabled because of injury or illness resulting from the job. Workers' Compensation law covers all employees.(Institute of Medicine, 2001).

Work-related musculoskeletal disorders (WRMSDs): WRMSDs are conditions involving the soft tissues of the body, including muscles, tendons, nerves, cartilage, and other support structures, caused by exposure to work-related risk factors.(Institute of Medicine, 2001).

Implications for Social Change

The study has important implications for social change. WRMSDs have negatively impacted the workplace in that workers are being asked to perform more risk-related tasks that often lead to injury on the job. Injuries on the job have negative consequences for employers and employees. (Sanders,2004). The study seeks to increase employers' awareness of ways to prevent WRMSDs by providing training designed to decrease workers' injuries and increase safety, and contribute to higher performance and productivity in the workplace. In addition, WRMSDs cause significant financial strain, as they are responsible for up to 40% of Workers' Compensation claims. (Sanders,2004). A decrease in workplace will lead to a decrease in Workers' Compensation claims, which will be a financial benefit to employers.

The study provides important information about WRMSDs in an industry that researchers have largely dismissed or ignored. The information gathered from the study regarding work tasks may benefit other warehouse workers. Other companies may choose to implement some of the changes identified in this study in an effort to increase workers' satisfaction.

Summary

Chapter 1 presented the problem statement, purpose of this study, and significance of this study. This study investigated the association between the frequency of WRMSDs among able-bodied warehouse personnel and the factors hypothesized to be associated with the performance of manual handling tasks. Other risk factors examined and identified any secondary factors related to the relationship between the frequency of performing high-risk tasks and the development of WRMSDs. Chapter 1 presented the terms necessary for a thorough understanding of the research topics, and discussed the research questions and hypotheses governing the current study. In addition, the study reviewed the limitations and assumptions.

Chapter 2 is a literature review focusing on studies relevant to WRMSDS. It explores the causes and risk factor associated with WRMSDs, and describes studies that have supported the reasons certain industries have a higher incidence rate than others.

CHAPTER 2: LITERATURE REVIEW

Introduction

Chapter 2 provides a comprehensive review of the relevant literature regarding various aspects of WRMSDs and possible solutions that may allow management to effect change seamlessly. Multiple peer-reviewed journals provided the information in chapter 2. Some of these included legislative issues, Occupational Health and Safety, Ergonomics, Healthcare and Public Policy, and Journal of Public Health.

Literature Review

The National Institute for Occupational Safety and Health (NIOSH, 2007a) stated that WRMSDs represent a significant problem in many industries. WRMSDs are a serious problem for both employers and employees because of the negative consequences. Approximately 1 million individuals took time away from work in 2005 because of WRMSDs (Institute of Medicine, 2006). Back pain is the most common WRMSD and accounts for up to 40% of reported cases (U.S. Bureau of Labor Statistics, 2009). In 2007b, the NIOSH described the scope of the issue regarding costs associated with WRMSDS:

> Back disorders accounted for 27% of all nonfatal occupational injuries and illnesses involving days away from work in the United States. The economic costs of low back disorders are staggering. In a recent study, the average cost of a workers' compensation claim for low back disorder was $8,300, which was more than twice the average cost of $4,075 for all compensable claims combined. Estimates of the total cost of low back pain to society in 1990 were between $50 billion and $100 billion per year, which a significant share (about $11 billion) borne by the workers' compensation system. Moreover, as many as 30% of American workers are employed in jobs that routinely require them to perform activities that may increase risk of developing low back disorders. (p. 11)

The magnitude of the costs of WRMSDs to society and individuals is significant. As such, research targeted at identifying the factors that contribute to the development of WRMSDs will be helpful in the development of interventions targeted at prevention. The majority of studies examining WRMSDs have focused on the health care industry (Block & Evans, 2006). The current study will focus on warehouse workers because the literature has not adequately reviewed this population. Through the identification of predictive factors, researchers may be able to create training programs that will result in a decrease in injuries and a subsequent increase in productivity.

WRMSDs are also known as cumulative trauma injuries (Block & Evans, 2006). According to the model, injury results from the accumulated effects of workloads that by themselves may not create damage. However, after repeated cumulative exposure, some workloads may result in injury. Cumulative trauma is concerned with the biomechanics of body movements, that is, through the tensing and relaxing of muscles. The muscular system is composed of ligaments and tendons that work in conjunction with muscles. Injury can result when tendons, muscles, or nerves receive repeated stress. The three most common forms of cumulative trauma are tendonitis, tenosynovitis, and carpal tunnel syndrome. Tendonitis is an inflammation of the tendons, tenosynovitis is the inflammation of the synovial sheath, and carpal tunnel syndrome is the result of a compressed median nerve.

According to Kumar (2006), researchers have asserted that repetition of tasks may contribute to cumulative trauma. Another factor is posture, especially if the individual remains in the same position for an extended period. Lack of rest also has been associated

with cumulative trauma. Some of the symptoms of cumulative trauma include tingling or numbness, shooting pain, loss of strength, loss of coordination, and discomfort (Smith & Carayon-Sainfort, 2005). WRMSDs occur because of a mismatch between the physical capacities of workers and the physical demands of their jobs (Sanders, 2004). Each year, millions of workers in the United States report such WRMSDs as carpal tunnel syndrome, tendonitis, and back injuries. Sanders asserted, "MSD is a widespread occupational health problem, with negative consequences for the worker and the employer. While the reported problem is most common in manufacturing, there are also emerging problems in the service sector" (p. 54). Many of these injuries are serious enough for workers to require time off to recover. This type of situation creates a negative situation for employers and employees. In most cases, the employers bear the biggest consequences because medical expenses and time away from work result in lower productivity. One of the solutions to these injuries lies in ergonomics. Implementing ergonomics in the workplace may help to reduce reported injuries substantially (Kumar, 2006).

Ergonomics

Ergonomics is a discipline that involves arranging the environment to accommodate the person (Kumar, 2006). It encompasses physical and environmental job stressors. Physical stressors refer to joints, muscles, nerves, tendons, and bones. Environmental stressors refer to hearing, vision, general comfort, and health. Physical stressors associated with WRMSDs are repetitive movements, vibration, excessive force, and awkward positions. Occupations that require extensive amounts of typing can result

in repetitive movements associated with WRMSDs. The use of jackhammers or other electronic equipment can result in vibration movements associated with WRMSDs. Those movements associated with excessive force are many construction jobs that require heavy lifting. Lastly, positions requiring awkward movements, such as holding a phone, have been shown to contribute to WRMSDs. Environmental factors such as air quality and noise also are associated with WRMSDs. Poor air quality may induce headaches, congestion, fatigue, and allergies. In addition, loud noises, particularly noises from heavy machinery, can affect hearing. Inefficient lighting may have an adverse effect on vision by creating eyestrain. (Kumar, 2006)

Many workplaces have implemented practices to reduce physical and environmental stressors Daltroy et al., (2007) asserted that one of the key factors in ergonomics in relation to individuals is to listen to the cues that the body signals. Individuals should learn to make adjustments within their environment in an effort to reduce the development of WRMSDs.(Daltroy et al.,2007). Some of these might include taking breaks or stretching sore muscles (Sanders, 2004). Other adjustments might include ergonomic postural positioning devices and making sure that individuals use proper posture.(Sanders, 2004). Employees are encouraged to discuss any needed adjustments to the work environment with employers (Kumar, 2006).

Effect of WRMSDs on the Body

In the industrial setting, workers often are required to do jobs that require turning and twisting, bending, or lifting. (Daltroy et al.,2007). All of these activities can lead to

WRMSDs. In addition, tasks such as standing or sitting in one location for a long period can cause discomfort. (Sanders, 2004).

No particular variable is responsible for WRMSDs. Carpal tunnel syndrome is a common WRMSD (Campeau, 2006). Causes of carpal tunnel syndrome include inflammatory and metabolic disorders, repetitive trauma, tumors, and developmental disorders. Workers who acquire these injuries often have occupations that involve working at a computer keyboard or performing repetitive tasks. Assembly workers, meat cutters, and poultry processors have reported a high incidence of carpal tunnel syndrome in the workplace as well. Commonly cited symptoms of WRMSDs include neck strain, shoulder joint, and pain in the hand and lower back (Campeau, 2006).

Work-related injuries have had a negative impact on many occupations and it has affected some industries more than others. “In 1998, nursing and personal care facilities were at the top of industries rate of MSD rate followed by pottery and related products” (Conway & Svenson, 2006, p. 40). Another study conducted by the Occupational Safety and Health Administration (OSHA) in 2000 (as cited in Sanders, 2004) concluded that meatpacking plants and poultry-slaughtering and processing businesses are among the top industries reporting high rates of WRMSDs. In addition, industries that involve manual handling and repetitive tasks are more likely to have workers with more workplace injuries than industries that do not require workers to perform these types of tasks (Sanders, 2004).

According to Chaffin (as cited in Hoozemans, Van, Allard, & Monique, 2007), the risk of health complaints (e.g., low back pain) induced by pushing and pulling can

arise from two types of hazard. One of the most common injuries is the result of overexertion, which happens when the musculoskeletal system has to perform beyond its capacity. Another reason these injuries occur is that pushing and pulling often force the musculoskeletal system to function in a way that is different from normal; in addition, the strain of pushing and pulling usually result in slips and falls.

WRMSDs: A Worldwide Dilemma

WRMSDs is not just a problem that exist in one region it is a worldwide dilemma that is worldwide.

Sanders (2004) asserted:

> Our society prides itself on the belief that technical advancement in information processing, manufacturing technology and medical science will enhance the quality of life for all individuals. Logic dictates that if we work more efficiently, we will be more productive and therefore, more satisfied with our personal work, our wages, and the use of our leisure time. (p. 3)

The hidden costs of doing business in a highly technical society have gradually undermined the basic assumptions that underlie this logic. Because many industries use these philosophies to stay abreast of technology and to gain financial advantage over their competitors, they have failed to provide the safest workplace environments for their employees.(Kumar,2006). As a result, workers have filed more accident reports of work-related injuries in the workplace over the past 15 years. (Kumar,2006). Many of the injuries that have occurred have been the result of inadequacies or a lack of safety intervention in the workplace.

More safety invention would decrease WRMSDs, according to the Institute of Management and Administration (IOMA, 2004b), which stated that the

> Financial burden of serious work-related injuries and illness grew to $45.8 billion from $44.2 billion in 2004. The financial impact of workplace injuries is outpacing inflation, with employee injuries now costing U.S. businesses nearly $1 billion per week. (p. 4)

Employers should bear some responsibility for this problem(s) because providing the safest working environment possible has become secondary to making profits and providing companies with a high return on their investment. (Sanders, 2004). The current financial state in the United States favors an employer market over an employee market, which allows employers, to demand more from their employees. (Dong & Bowles, 2005). Economic slumps have meant pain and suffering for many industries and individuals. One example was the huge staffing buildup that preceded the sudden economic downturn during the late 1990s and early 2000s (Dong & Bowles, 2005).

WRMSDs are a global problem. With the pressure of competing in a global market, companies are trying to be more productive without ensuring safe, injury-free work environments.(Sanders,2004). WRMSDs probably have a more negative impact in developing countries because of the lack of technology and because most of the focus is placed on basic survival needs rather than ergonomics interventions.(Sanders,2004). Work-related injuries will continue to increase unless management personnel take more responsibility for these problems and provide interventions that safeguard their employees from preventable injuries (Sanders, 2004).

Management Concerns about WRMSDs

Because WRMSDs are a major concern of many industries, management personnel often need to find ways to prevent WRMSDs. In an effort to change the way work is being completed by employees, many companies are developing new strategies

for the daily processes of data management, office procedures, office management, workplace automation, workplace design, and risk evaluation. Sainfort, Karsh, Booske, and Smith (2005) commented:

> New theories of work organization and design to address automation and workforce issues have emphasized the need for more workforce involvement in the planning for automation and during the implementation of new technology, and for the better workplace design to enhance human-machine interfaces. (p. 99)

Companies are now making the effort to offer more employee meetings and to list safety information on bulletin boards and company web sites. Managers need to educate themselves on ways to make their employees safer and more efficient while they doing their jobs (MacLeod, 2005).

It is important that managers address WRMSDs and begin the process of intervention and prevention in order to provide a safer workplace environment that could have a beneficial outcome for employees and employers. Perhaps one of the issues facing managers includes the decision to implement programs that are valuable and cost effective. Before implementing any technological change, managers should examine its potential positive and negative influences on other work system elements. The implementation of technology may ultimately affect individual outcomes, such as quality of working life (i.e., job satisfaction and stress); perceived quality of care delivered; or self-rated performance. Inadequate planning could be a disaster for both employers and employees if management personnel fail to provide some solution to WRMSDs in the workplace environment (Kumar, 2006).

Taylor, (1911/2004), the father of scientific management, was one of the most influential people of his generation during the Industrial Revolution because he

implemented methods and procedures to improve an organization's performance. Prior to the Industrial Revolution, the focus was more on making sure that the workers got the tasks done (Taylor, 1911/2004). During the Industrial Revolution, the focus shifted to making sure that workers and machinery got the tasks done more efficiently and effectively.

It was during the 19th century that Taylor pioneered the scientific management method (Pratt & Kleiner, 2005). This approach sought the single best method to perform a job by incrementally reducing the size and the weight of coal shovels until they reached the optimum shoveling rate. By doing this, Taylor tripled the amount of coal that workers could shovel in a day (Zink, 2006).

Taylor's (1911/2004) methods were used in the early 1900s by Gilbreth and Gilbreth to develop a time and motion study that sought to improve efficiency by eliminating unnecessary steps and actions. By applying this approach, "increased the number of motions in bricklaying from 18 to 45, allowing bricklayers to increase their pace of laying bricks from 120 to 350 bricks per hour" (as cited in Hendrick, 2007, p. 2).

During this time, the Industrial Revolution had gained momentum and "assembly-line pacing, predetermined motion and time standards, long hours at work, and the performance of repetitive tasks became the norm. The serious and problematic nature became increasingly apparent" (Sanders, 2004, p. 5). Because of the high number of injuries among workers and the time away from work, employees and employers developed compensation laws to protect themselves. Upon the implementation of these compensation laws, companies began to record occurrence and severity of the workers'

injuries. Physicians began to analyze these injuries to determine if they were work related or the result of other contributing factors, such as one's tolerance for pain.

Taylor's (1911/2004) understanding of scientific management consisted of four important principles that should apply to any organization:

1. Time study rate system: Use this approach in the observation of workers within the organization. The fastest workers, classified as first-class men, set the standard for other workers to achieve the same or greater production by making other workers accountable for minor adjustments for newness at the job and unavoidable delays.
2. Creation of functional foremen: This concept of supervision is carried out completely differently from how supervision is used in the military. Although management or supervisory staff is responsible for job duties and job tasks, the extent of their role is to supervise some aspects of work, not supervise people.
3. Establish cost accounting: This approach involves the use of instructions, routing cards, and timekeeping systems that have workers punch a clock when their shift is completed. This system establishes a reporting tool that analyzes labor variance. It also identifies bottlenecks.
4. Devise a system for pay versus position: The purpose of this method is to eliminate bonuses at the end of the year and to avoid paying one position more bonuses without having a standard to justify a higher bonus. In addition, this process seeks to eliminate job rotation and focuses on specialty employees.

Before Taylor, the emphasis of many organizations during the 19th century was to see that workers got the work done and managed themselves. Although this emphasis remains somewhat true, more organizations are using a systemic approach to get work done, perform processes, and improve productivity and efficiencies.

Today, many of Taylor's (1911/2004) concepts are being used by organizations and industries. For example, the auto industry uses a lean system to ensure that only the inventory parts needed to manufacture cars are used. Taylor (1911/2004) This process systemically eliminates waste and increase productivity and efficiencies. Taylor (1911/2004). Assembly lines, now designed to build each part separately, saves time on the complete assembly.(kumar,2006). The focus has shifted from productivity to safety and productivity in recent years.(MacLeod,2005). However, modifications in many of the processes that Taylor designed are still effective in improving productivity and efficiencies.

A number of theorists have proposed pathways that link physiological factors and strains with musculoskeletal outcomes. Sauter and Swanson (as cited in Faucett, 2005), found that the combination of work stressors and work performed outside of the job increases the burden on workers. Some of the symptoms of work stressors include anxiety and depression, loss of confidence, sleep impairment, and so on. Sauter and Swanson believed that workers who suffer from these conditions often experience a decrease in performance and poorer posture at work. Factors such as job demand and control over job-related individual attributes contribute to some form of WRMSDs (as cited in Faucett, 2005).

Lazarus'(as cited in Faucett,2005) closely linked his theories to Saunter and Swanson's philosophies. Lazarus proposed that variations in responses to everyday stressors, "such as those at work, correspond to differences among individuals in their coping skills and also appraisal of the adequacy of their ability and resources" (Faucett, p. 532). Faucett asserted that in occupations that require physical labor, higher frequencies of WRMSDs often occur. Conway and Svenson (2006) suggested, "Employees in industries with low MSD rates in 1998 received above average hourly earnings and had greater average productivity gains. Conversely, employees in industries with high MSD rates had below average hourly earnings and recorded low productivity gains" (p. 32). After collecting numerous journal articles on this topic it is this researcher belief that workers who perform task that are repetitive and requires constant lifting are more likely to obtain work-related musculoskeletal disorder symptoms.

Lazarus also believed that psychological responses emerge from an interaction or transaction between external demand and individual attributes (as cited in Faucett, 2005). Similarities existed between Lazarus and Levi. Both philosophers developed a physiological approach to stress, and they recognized the importance of psychological factors as primary determinants of stress sources. Lazarus and Levi studied and analyzed the ability of people to handle stress and the factors that precipitate stress in the workplace. Levi believed that psychosocial activities at work or outside of work contribute to work-related illness. In addition, he focused on the relationship between physiological and psychosocial factors and individuals' different reactions to stress. Levi concluded that individuals are likely to experience different stress levels because of work

and outside factors that may, or may not, contribute to work-related injuries (as cited in Faucett, 2005).

Feuerstein (as cited in Faucett, 2005) strongly believed that workers may develop habitual patterns of working over time that increase their risk of WRMSDs. This viewpoint was consistent with other studies that have found that performing repetitive tasks increases the risk of MSDs through heightened reactivity. The facts are evident in the food products and manufacturing industries, which generally have the highest rate of WRMSDs. It is common knowledge that these workers perform repetitive tasks on a daily basis such that the number of incidents has shown a positive a correlation to why these industries have the highest rate of work-related injuries (Statistics, 2002, as cited in Sanders, 2004). “Meatpacking plants had the highest incident rates, with a stunning 812 out of 10,000 workers, followed by motor vehicle manufacturing which reported 727 cases out of 10,000” (Sanders, 2004, p. 46). Another study in an automobile assembly plant showed that over a 10-month period, the workers who performed repetitive jobs were more likely to sustain work-related injuries (Buckle, 2005). The results showed that 93 of the 259 participants in the study complained about shoulder injuries. These workers consistently performed repetitive task using their shoulders during the 49-day study (Buckle, 2005).

Feuerstein (as cited in Faucett, 2005) also believed that factors such as work style that organizations and management force onto their workers to increase production creates fear about performance, which can make workers frustrated and less focused on their daily tasks. Behavior responses to stress may have a negative effect on workers. For

example, if workers are not getting the proper rest period, they may have negative physiological responses that affect changes in their muscle, neurological, immunological, and vascular processes. This relates to WRMSDs because physiological and psychological factors contribute workers either under or over exerting muscles at work and at home (Faucett, 2005).

Unlike the theorists already mentioned, Smith and Carayon offered a different conceptualization of the broad array of organizational factors that may influence WRMSDs (as cited in Carayon, Haims, Hoonakker, & Swanson, 2006). Smith and Carayon implied that WRMSDs should include a large variety of job-related factors and physical ergonomic stressors, in addition to work organization stressors as potential causes (as cited in Carayon et al., 2006). One common example of Smith and Carayon's philosophy is adjusting one's chair to a comfortable position in order to perform work at the computer. Because people have different physical characteristics, what might be comfortable for one user may not be comfortable for someone else. Good posture is an important basic requirement of workspace design. Poor posture may result in injuries and extreme discomfort, which could make the task more difficult or unbearable. Job stressors produce emotional, behavioral, and physiological responses that influence workers' health and the emergence of stress-related outcomes such as WRMSDs (Faucett, 2005).

Assessment of Duration and Frequency of Work Tasks

Winkel and Mathiassen (Kallio, Juntura, Hakkansen, & Takala, 2005) commented, "Quantitative assessment of physical load is needed in the assessment of the

effects of ergonomic inventions and should be attempted in epidemiological research of risk factors for musculoskeletal disorders" (p. 610). The use of quantitative methods helps to obtain the best data, validity, and reliability, because the quantitative estimation of physical workload requires breaking down the jobs into smaller entities to determine time duration and workload capacity (Kallio et al., 2005). It is essential that when addressing questions related to the proportion of the total workload when assessing physical workload, that they are measurable. Using different methodologies occurs in the assessment of short-cycle jobs compared to long-cycle jobs and the analysis of each work task(s). First, in short-cycle jobs without daily variations, "random sampling of work cycles for further analysis is an option for exposure assessment strategy" (Kallio et al., 2005, p. 45). "One method of breaking down a large job cycle is to break them down into tasks and subtask with subsequent assessment of their frequency and duration." (Kallio et al., 2005, p. 611). Because the data can be difficult to assess on frequency or duration of the task, the worker may be the best resource to provide a detailed description of the physical workload and frequency of each task (Kallio et al., 2005).

Industrial Workers and WRMSDs

The specific research questions for this study were the following:

1. How do the high-risk and handling tasks of warehouse personnel relate to WRMSD symptoms?
2. How are workload and WRMSDs different by job category among warehouse personnel (warehouse workers, stockroom clerks, and forklift drivers)?

3. What is the nature of the relationship between the at-risk classification rating and the frequency of WRMSDs among warehouse personnel?

Industrial work environments such as warehouses, stockrooms, checkouts, and assembly lines often require that the workers stand for long periods. Ergonomists and human factor professionals could take a proactive approach in making these environments more comfortable and safe for workers. Industrial workers also need to inform management personnel about what they can do to help them perform their jobs better.

Tissot, Messing, and Stock (2005) undertook a study that focused on two areas to gain a better understanding of the consequences of standing: subjective indices and objective physiological indices. Tests conducted in the subjective indices, measured participant reaction after standing between 1.5 and 3 hours; noted body posture, and collected data to identify the types of aids that could help workers perform their jobs while standing. In the objective indices, the use of a number of physiological markers tested the participants' heart rates while they were standing, and measured leg volume before and after the work performance (Tissot et al., 2005).

The results of the subjective indices showed that when the participants had adequate rest periods between standing and resting, they felt more comfortable (Tissot, et al., 2005). Results also included increased productivity. When the participants did not get the proper rest periods, they felt more discomfort, which resulted in less productivity. The results of the objective indices showed that the heart rate increased when the workers stood on a concrete floor instead of a carpet. In addition, the participants who used

standing aids to help them perform the same job task had less swelling in their legs than the other participants did (Tissot, et al., 2005).

Following are recommendations that may reduce workers' stress, increase their comfort level while standing, and help them to perform their jobs better:

1. Flooring that is more flexible would improve the workers' ability to stand for longer periods, and it would reduce the foot, leg, and back pain that often occurs from standing constantly on a concrete floor.
2. Shoes with better support would give the workers an overall better comfort level and may prevent injuries due to discomfort levels.
3. Implement walking programs by organizations that require employees to stand. In addition, walking would help to pump the blood out of the legs, which would help to relax workers after they have been standing for long periods.
4. Sitting or standing could help to prevent the workers from getting tired faster. Sitting, while performing tasks, could give the workers more comfort and may help to increase productivity (Tissot, et al., 2005).

In the future, more employees may be required to stand for longer periods while performing their jobs, which will compel researchers in ergonomics to provide workers with standing aids.

The challenges facing management personnel to provide a safe work environment cannot be overemphasized. Many organizations have incorporated ergonomics in the workplace to revamp and/or increase the safety of their working conditions. The IOMA's report discussed five examples of ergonomics (2004b). Workstations ergonomics were

among the examples that Drewczynski (Bryant, 2005) found to offer simple solutions to ongoing safety problems. After testing 36 work groups from nine organizations, the researchers from Bell Laboratories (IOMA, 2004b) found that a single, short educational session with supervisors and computer users had a positive effect on how many people in a work group modified or had modifications done regarding workplace design and working technique.

Safety professionals have come to understand that workers who have high levels of job strain often have a greater risk of injuries and other health problems. In certain occupations, there is no way to avoid the high risk of injury from the constant lifting or towing of equipment. However, many organizations realize that absenteeism and lower productivity will have a higher long-term cost. Ergonomics does not solve all of the problems associated with job strain, but providing the right equipment with human factor design in mind can be a substantial health benefit to workers in low-control, high-demand jobs (Sanders, 2004). Another study by Princeton University cited in the IOMA's (2004a) report found that workers who perform work at 2 a.m. are typically at higher risk than those performing similar tasks during a 9-to-5 schedule, even after adjusting for worker fatigue, industry, and occupation. The suggested solution is to consider shift times, not just shift length, in devising employees' schedules.

Computer manufacturers are now including devices that will increase computer users' comfort and reduce their physical strengths. Utilizing typing-test groups that alternated between split keyboards and traditional models, researchers from Bell Laboratories (as cited in IOMA, 2004b) were able to measure the muscle strain

associated with work-related injuries. The findings suggested that computer users have a 50% chance of replacing old keyboards with ergonomics keyboards when the need arises.

Sitting at a computer or operating machinery on the production line involves repetitive physical actions. Calderwood (2006) reported that repetitive tasks and physical actions are a prime reason for injuries. The new ergonomics rules will apply to any worker who kneels or reaches for items for more than 2 hours in the workday. It also applies to individuals who use vibrating power tools for more than 30 minutes a day or who lift more than 75 pounds just once a day or 55-pound objects more than 10 times a day. Also covered are employees who use a keyboard or a computer mouse for more than 4 hours a day. All workers, covered under these terms, receive convalescence leave with pay for up to 90 days for ergonomic injuries. There is no limitation on successive 90-day convalescent periods. If only one employee reports an ergonomic injury, the employer must examine the job tasks and work area of that employee and other similar situations that might require corrective action.

Many business groups have opposed these regulations. It is apparent that these new rules will force companies and industries to provide safe ergonomic practices. Businesses that oppose this new ergonomic law believe that they will incur the cost of injuries not caused in the workplace. Although this situation may arise in some cases, the OSHA is convinced that even though the cost of American industries to comply is about $4.5 billion, industries will save $9.1 billion annually because of reductions in time away from work and lost productivity. A number of organizations are lobbying Congress to

stop these regulations, and several lawsuits have challenged the rules and requested the courts to stop implementation.

According to Goldsheyder, Weiner, Nordin, and Hiebert (2004), workers employed in construction and industrial occupations are at some of the highest risk for multiple health challenges. These numbers are in correlation to work absenteeism due to injury. Among the injuries that these workers suffer at high rates are WRMSDs. Many workers retire early or are placed on disability because of these injuries. It is apparent that the tasks performed by these workers are the reason for the high rate of injury.

Goldsheyder, et al. (2004) administered a survey of 110 questions to a sample of 200 industrial workers in a 2-week span. Analyses of the data revealed that most of the respondents worked in more than one job category and performed a wide variety of jobs. Most of the workers performed jobs that had multiple ergonomics hazards, such as heavy lifting, repetitive tasks, awkward posture, bending, and twisting, which often resulted in WRMSDs. The researchers commented:

> The survey findings revealed that about 77 of the workers experienced at least one musculoskeletal symptom in the twelve months prior to the survey. LBP (lower back) was reported experienced (66%) in the trade. Due to the number of back pain, 15% of the workers were absent from work and 21% of them visited a physician seeking treatment. (p. 115)

Shoulder pain was the next most frequently reported WRMSD symptom. Based on the data that were collected, the main factors that contributed to the increased rates of WRMSDs in the industrial environment were correlated to the workers' increased workload and awkward postures, forceful exertions, highly repetitive movements, fast-

paced work, and exposure to extreme environmental conditions, as well as a clear lack of safety training and personal protection on the job (Goldsheyder et al., 2004).

"Very few studies on work-related physical risk factors for low back have included standing posture and/or walking as a potential risk factor" (Tissot et al., 2005, p. 250). Tissot et al. conducted a study in Quebec in 1998 to collect data on 1.5 million residents (see Table 2). Some of the questions evaluated different types of sitting and standing postures according to mobility (time spent walking) and constraint (ability to choose posture freely/access to sitting or standing). The researchers commented:

> "in this study, the following questions were examined (1) what are the prevalence and variability of types of standing and sitting work posture in the Quebec population? (2) How does the prevalence of these postures vary according to gender? Does the prevalence of sitting and standing postures vary with regard to socio-demographical characteristics or with psychological and physical work demands known to be associated with musculoskeletal disorders (MSDs) and measured in the Quebec working population" (p. 251)

Screening for WRMSDs

Goldsheyder et al. (2004) stated:

> A survey questionnaire is a useful tool in ergonomics field studies to assess the presence of symptoms of WMSDs, to characterize job factors associated with the development of these disorders, and to assess symptoms and associated outcomes before and after an ergonomic intervention. Relatively inexpensive, the standardized self-administered symptom questionnaire appears to be a sensitive and reliable surveillance tool for tracking early symptoms of WRMSDs. (p. 32)

One of the most effective methods of screening for WRMSDs is having a group of employees fill out a questionnaire. Recent studies have focused on the impact of the safety and health of workers to help to prevent WRMSDs. Oxenburgh performed a study in 1997 (as cited in Sanders, 2004) that took a comprehensive approach to costing out

WRMSDs in relation to the costs of ergonomics (cost vs. benefits) for individual companies. He commented:

> The example Oxenburgh used was that of a factory that makes parts that need to be sanded very smooth. This operation was done by four people by hand, all day long, resulting in extensive hand problems both from the sanding done with the right hand as well as gripping of the part done with the left hand. As workers became disabled, others had to pick up the work and started working extensive overtime, which led to more problems. (as cited in Sanders, 2004, p. 53)

Another study conducted in 1996 by the Canadian Auto Workers Union and McMaster University found that a third of the employees suffered some type of work-related injuries while working (as cited in Kome, 2006). Both of these studies raised the awareness of employers about the importance of having the right equipment and tools to provide employees with a safer workplace environment. In a study administered by the National Health Interview in 1988, construction workers, lumber and building material retailing, and the nursing occupation were among industries reporting the highest rates of back pain (as cited in Guo et al., 2006).

According to Snook and Webster (2007), more than half of all compensable back pain injuries have has been the result of the manual manipulation and handling of objects. Organizations are now focusing on improving workplace design to reduce WRMSDs. Musculoskeletal system and psychological illnesses can be partly ascribed to poor equipment design, inadequate technical systems, and challenging tasks. Ergonomics may reduce the problems by improving working conditions. In a number of countries, occupational health services are obliged to employ ergonomists.

In a study of WRMSDs among concrete and cement workers, Goldsheyder, et al. (2004) developed the lengthy Musculoskeletal Symptoms and Work History

Questionnaire specifically to collect data from cement and concrete workers. Goldsheyder, et al. found that the instrument had adequate reliability and construct validity for these workers. They also found that criteria validity often is difficult to assess in questionnaires. The findings showed that these workers were at increased risk and that without an intervention strategy to address the problem, they would suffer higher incidence of WRMSDs. The researchers concluded that the vast majority of these workers expressed a strong interest in learning more about safety regulations and injury prevention strategies, safe lifting techniques, and the proper use of lifting equipment. Lemasters et al. (2006) asserted:

> Criteria validity is the degree to which the measures correlate with an external criterion commonly referred to as a gold standard. Finding a criterion for evaluation of symptoms of musculoskeletal disorders is problematic because there is no gold standard in diagnosing these conditions. (p. 439)

Dempsey and Filiaggi (2006) investigated task demands and WRMSDs among restaurant wait staff. In addition to lifting, twisting, and turning, wait staff often are required to stand for long periods of time, which usually contributes to some form of WRMSDs. They commented:

> A cross-sectional study of task demands and musculoskeletal discomfort among a sample of 100 wait staff in ten casual dining restaurants was conducted. In addition to answering a questionnaire about musculoskeletal discomfort and symptoms experienced in the past 12 months and attributed to work, subjects were asked about various aspects of their jobs, such as shift length, number of shifts per week, and safety training. (p. 93)

Because of overwork, low pay, a lack of professional recognition, and the large number of people employed in the food service industry, Dempsey and Filiaggi predicted that WRMSDs would continue to increase. In addition to the physical demands, the food

service industry also has high psychological demands. The study focused on 10 dining locations at eight restaurants; a total of 65 women and 35 males were involved in the study.

In analyzing the data from the restaurant wait staff, the results indicated that better assessment tools were in high demands to identify handling tasks found in the restaurant industry. The most frequent causes of injuries were slips and falls. Wait staff and servers worked in a kitchen in which the counters were at waist height. This provided an even assessment in the determinants of how frequency and weight contributed to musculoskeletal symptoms. "The frequencies of types of handling were food trays at shoulder height (167), food trays at waist height (8), [and] food trays plus miscellaneous items (4)" (Dempsey & Filiaggi, 2006, p. 99). "The majority of subjects reported a job title of server (87%), followed by bartender (9%). Nine of the ten managers reported safety training. Almost all respondents reported working more than one shift" (Dempsey & Filiaggi, 2006, p. 97). The results showed that the female workers suffered more musculoskeletal symptoms than their male counterparts did. One factor was that the wait staff and servers often held the trays with one hand, which resulted in overexertion. The findings showed that more ergonomics intervention would result in fewer injuries to the wait staff and servers.

WRMSDs and Gender

Arvidsson et al. (2006) conducted a study among traffic controllers performing identical and demanding work. A total of 90 females and 97 males participated in the study. The study focused on the psychosocial and the physical work environment of the

air traffic controllers. According to Taylor and Mish (as cited in Moon & Sauter, 2006), psychosocial pertains to mental or psychological as well as social aspects. Sauter and Swanson (as cited in Moon & Sauter, 2006) expanded on the definition to bring needed clarification. They stated, "Commonly recognized psychosocial factors include nonphysical aspects of the work environment or social milieu, often as reflected in expressed thoughts, feelings, perceptions, attitudes, and other behaviors" (p. 11). The physical work environment is the task or functions performed either by manual labor or by some type of physical movement. A large part of their jobs requires repetitive physical movements, especially with the computer mouse. Traffic controllers are likely to experience some form of WRMSDs (Arvidsson et al., 2006).

Cooper and Marshall (as cited in Moon & Sauter, 2006) explored the prevalence of WRMSDs and the perception of psychosocial work conditions among operators performing intensive computer work, with an emphasis on the differences in occurrence of WRMSDs between males and females performing identical tasks. The results showed that the females in the study had a higher occurrence of WRMSDs than the males did. Several studies have shown that females often have a higher incidence of work-related incidents while performing the same tasks as their male counterparts. According to Kome (2006),

> Women are at greater risk of having to work with the wrong equipment simply because most workplaces are built using anthropometric measurements. That is tables, chairs, desks, conveyer belts, hand tools, and workstations are all designed to accommodate the so-called average man. (p.123)

Treaster and Burr (2004) asserted, “Some studies have found women at greater risk than men, some have found men at greater risk than women, and some have found no statistically significant gender difference” (p. 496).

WRMSDs: The Regulatory Perspective

Most companies are profit driven, and mangers are under pressure to make profits for their companies. Organizations that do not have high safety standards, do not view health and safety regulations as a priority. Organizations that share this type of philosophy often try to avoid meeting safety requirements and regulations because they fear that the cost will affect their profits and production. Because WRMSDs may occur over an extended period, employers often question if employees’ injuries are due to unrelated work injuries. It is sometimes difficult to pinpoint when and why an injury has occurred. Employers should take a proactive role in solving the problem in terms of human and economic costs.

Because some organizations do not conform to the rules and guidelines, it is necessary to have regulatory agencies such as the OSHA and laws such as the Americans with Disabilities Act (ADA, 1990). They can take on the responsibilities of policing organizations that do not provide standard safety rules and guidelines to help prevent injuries in the workplace and of offering compensation to employees who suffer disabilities that hinder them from working at full capacity (Sanders, 2004). According to Morse, Dillion, Warren, Hall, and Hovey (as cited in Sanders, 2004), “Roughly between 10 to 25 percent of work related musculoskeletal disorder are unreported in the

workplace" (p. 47). These findings supported the notion that employers should focus on taking proactive measures and providing a safe workplace environment that meets the OSHA's standards.

Summary

WRMSDs are a complex issue among employers, employees, industries, and health care providers. WRMSDs are prevalent in the workforce, and without proper interventions and treatment, the problem may get worse before it gets better. Studies have consistently shown that musculoskeletal injuries affect people differently because of stress, physical work, and psychological and psychosocial factors. According to Kome (2006), some employers claim that personal factors play a major role in susceptibility to WRMSDs. Reviews and studies of job stress often are cited whenever one is trying to identify specific factors to explain why one worker may be affected by WRMSDs, but another worker who performs the same task may not be. Payne (as cited in Moon & Sauter, 2006) identified three classifications of variables corresponding to (a) genetic factors, intelligence; (b) acquired aspects (e.g. social class, culture, educational attainment); and (c) dispositional factors (e.g., personality characteristics or attitudes such as job satisfaction). Kasil (as cited in Moon & Sauter, 2006) asserted that WRMSDs affect people differently because of such factors as hours of work and work-rest period, work shift, and workplace.

Because many work-related injuries often occur over time, employers sometimes dispute employees' claims. Because of the nature of injuries involving WRMSDs, it can be difficult to prove if an employee has a legitimate claim. In addition to time away from

work and compensation paid to employees for their injuries, some employers view work-related injuries as a no-win situation. Although no studies have proven that implementing ergonomics will reduce work-related injuries in the workplace, improperly designed tools, inadequate working space, anatomically unsuitable work practices, and poor workstations designs are common causes of work-related injuries. Chapter 3 describes the methodology of the study.

CHAPTER 3: RESEARCH METHOD

Introduction

This study investigated the association between the frequency of WRMSDs among able-bodied warehouse personnel and the factors hypothesized to be associated with this discomfort, such as the performance of manual handling tasks. Conducted in Atlanta, Georgia, this research has a sample size of 71 participants. Distributed to 82 warehouses, questionnaires assessed workers' experience of physical ailments in the past week based on various demographic variables and work variables; 71 workers completed and returned the questionnaires. The analyzed data summarized frequencies and percentages, as well as means and standard deviations, where appropriate, for gender, years of experience, usual shift, job category, and other variables. Pearson's correlation coefficient analysis identified significant bivariate associations between two variables. The correlation coefficients indicated the strength and direction of the relationship between the variables. The observational and interview data triangulated with the quantitative data. To compare the different positions of the participants in the study, an ANOVA determined whether there were differences among warehouse workers, stockroom clerks, and forklift drivers regarding the number of at-risk handling tasks performed.

Research Design

This study used a quantitative, non-experimental, comparative, correlational research design that allowed the researcher to compare two continuous (interval or ratio level) variables to determine whether there was an association between them. These two

variables were the predictor variable (i.e., high-risk and handling tasks of warehouse personnel) and the outcome variable (i.e., WRMSD symptoms). When the predictor variable is continuous, a correlational design can assess how much one variable varies from another variable. This would be an indication of whether there is a positive or a negative relationship between the variables.

When the predictor variable is categorical (i.e., has two or more specific categories, nominal or ordinal), the researcher can examine the differences that may exist between two or more groups (Moore & McCabe, 2006). In the context of this study, the researcher was able to determine whether there were differences among the positions (warehouse workers, stockroom clerks, and forklift drivers) regarding the number of at-risk handling tasks. For this reason, the comparative design was appropriate to determine whether there were any differences among the participants with respect to the number of at-risk handling tasks.

The research design identified a comparison, or correlation, between the predictor and the outcome variable therefore it was quantitative. The researcher was able to quantitatively assign numerical values to the predictor and outcome variables and then make a comparison. The values for the frequency of WRMSD symptoms, the frequency of high-risk and handling tasks, job categories, the at-risk task rating, and the frequency of WRMSDs was obtained from two questionnaires, namely, the demographic questionnaire (see Appendix A) and the CMDQ (see Appendix B), both of which were designed to obtain the information required for this study. Using questionnaires rather

than object measurements is common in studies that assess physical load because of their cost and practicability (Wells et al., 2007).

The quantitative, non-experimental, comparative correlational design was appropriate for this study, whose objective was to determine whether there was a relationship between the frequency of WRMSD symptoms among warehouse personnel and the frequency of high-risk and handling tasks that the workers performed, as well as between the at-risk task rating and the frequency of WRMSDs among warehouse personnel. Because the aim was to determine whether there was a relationship between or among two or more variables, a quantitative design was more appropriate than a qualitative design, which would not have allowed the researcher to assess a direct relationship between two variables because of the open-ended questions. (Moore & McCabe, 2006).The responses to open-ended questions would have had to be interpreted and coded to identify trends or themes in the responses prior to analysis. (Moore & McCabe, 2006).This process would not have been as objective as a quantitative approach because quantitative studies base their responses on predetermined questions on survey instruments designed to measure the desired outcomes (i.e., WRMSD symptoms and other discomfort information).

A quantitative approach was appropriate for this study because it allowed the researcher to obtain the data via questionnaires that assigned numerical values to the variables. Then, statistical procedures, such as Pearson's correlation coefficients and ANOVA, could assess the data. The researcher did consider using an observational or a descriptive study design, but it would not have allowed the researcher to determine

whether there was a relationship between the variables. The purpose of an observational or a descriptive design is to make conclusions based on observation alone. In other words, no inferences can be made based on the collected data.(Moore & McCabe, 2006).

For the purpose of this study, Pearson's correlation coefficients evaluated Hypothesis 1 and Hypothesis 3. The purpose of the correlation coefficient was to determine whether there were significant positive or negative correlations between two continuous variables (Moore & McCabe, 2006). Hypothesis 2 was evaluated by using a one-way ANOVA because the goal was to determine whether there was a difference among warehouse workers, stockroom clerks, and forklift drivers regarding the number of at-risk handling tasks performed. If there was a significant difference among the job positions, the researcher conducted a post hoc analysis. The study discusses this test in more detail later.

Data Collection

Mendenhall, Beaver, and Beaver (1999) defined- the population for a study as the group of participants or objects to which statistical inferences can be applied. In this study, the population of interest comprised manufacturing facility workers located in Atlanta, Georgia: including warehouse workers, stockroom clerks, and forklift drivers. The researcher used convenience sampling, which is a form of nonprobability sampling; this means that the researcher selected participants as they come along (Urdan, 2005). Convenience sampling has an advantage over a probability sampling method such as random sampling because it allows the researcher to obtain more data in a shorter period.

The warehouse workers, stockroom clerks, and forklift drivers who chose to, provided their e-mail addresses. They were included in the sample based on whether they voluntarily completed the online questionnaires.

Following approval to conduct this study from Walden University's Institutional Review Board (approval # 11-30-09-0285590), the potential participants received a recruitment flyer through e-mail (see Appendix C), and an informed consent form (see Appendix D). Once they agreed to participate in the study, they completed a coded demographic questionnaire and their names removed. The participants were not identified during the data analysis phase. The demographic questionnaire included individual factors, such as gender, and exposure factors, such as years of experience, usual shift, and job category. In addition, the questionnaire included two questions with a Likert scale of 1 (*never*) to 5 (*always*) to determine whether the participants had help with handling and movement tasks and whether the participants' handling and movement of equipment caused discomfort.

The researcher collected the data and then separated them into job category, age, and gender through the direct observation of staff performing tasks and information collected on the demographic questionnaire. In addition, the researcher assessed whether there was a difference in the number of at-risk tasks performed among the different job categories. The participants completed the CMDQ based on the Nordic Musculoskeletal Symptom Survey (Kurinka, et al., 1987). Brigham and Sinclair (as cited in Kurinka, et al., 1987) commented, "From an epidemiological viewpoint, it is evident that this type of

questionnaire is most applicable for cross-sectional studies with all the concomitant limitations" (p. 232). Kurinka, et al. commented:

> Standardisation is needed in the analysis and recording of the musculoskeletal symptoms. Otherwise it is difficult to compare the results from different studies. This consideration was the main motive for a Nordic group to start developing standardized questionnaires.(p.231)

The researcher assessed each participant's manual handling workdays for 7 consecutive days, commencing on a Monday. The source of data included a worksheet with space for the following information (see Appendix E):

1. Identify the tasks associated with a high incidence of musculoskeletal symptoms among warehouse personnel.
2. Rate the frequency of the tasks and determine whether they are at a high, medium, or low risk of performance for obtaining work-related musculoskeletal symptoms among warehouse personnel.

Once the study was completed, a computer spreadsheet, comprised of the raw data from the questionnaires, such as Microsoft Excel, remained available for future analysis. Each participant received an identification number correlating to each row in the Microsoft Excel spreadsheet. This identification number ensured that the responses obtained from the questionnaires corresponded to the participants. A separate flash drive comprised the data and then stored in a filing cabinet to which only the researcher had access. This procedure protected the confidentiality of each participant. The data will be kept on file for 5 years, after which time they will be destroyed and deleted from the flash drive.

A power analysis and a sample size estimator were conducted to ensure that the researcher could make valid inferences about the target population based on the sample size. Therefore, based on this information, three items contributed to calculating the required sample size for the study. The first item was the power of the study, which refers to the probability of correctly rejecting a false null hypothesis (Keuhl, 2000), that is, not making a Type II error in terms of statistical analysis. The second item used to calculate the power of the study was the desired effect size that the researcher wished to obtain. The effect size is the strength of the relationship between the predictor and the outcome variables (Cohen, 1988). In other words, the effect size identifies how much of the variation in the outcome variable can be explained by the predictor variables. The third item was the level of significance, which determines the level at which the null hypothesis is to be rejected. Alpha (α) defines the level of significance and is usually set equal to 5%.

Assuming that the researcher required a large effect size with a level of significance of 5% and a power of 80%, then the minimum sample size required for this study was 52 participants. A correlational research design used to measure the association between the frequency and number of different workplace discomforts provided the information for the calculation. The CMDQ measured the different degrees of musculoskeletal disorders. These different levels allowed the researcher to compare the variables to determine whether there was a significant relationship between the frequencies of musculoskeletal disorders with frequency of high-risk and handling tasks, at-risk rating, and frequency of WRMSDs.

Eligibility Criteria

To be eligible to be in this study, the potential participants had to be 18 years of age or older, and they had to be employed as warehouse workers, stockroom clerks, or forklift drivers in a manufacturing facility in Atlanta, Georgia.

Participant Confidentiality

All participant records will remain confidential. Each participant's name on the survey linked to a data assignment; however, once linked, the name was removed. The researcher kept a list of the participants and their social security numbers for tax purposes in a locked drawer accessible only to the researcher. The results of the study will not include any of the participants' names or other information that may identify them.

Recommendations and Conclusion

Based on the data collected employers can prevent WRMSDs by properly designing the job or the workstation and selecting the appropriate tools or equipment for a particular job. The design for work tools and equipment needs to include ergonomics. The designs of most hand tools consider only occasional use, not for repetitive use over a prolonged time. The maintenance of tools and equipment is essential in preventing or reducing ergonomic hazards. Proper maintenance may help to reduce vibrations resulting from prolonged equipment operation. In most industries, employers can prevent injuries in the workplace by establishing procedures to correct or control risk factors by following such work practices as proper lifting techniques and keeping work areas clean; installing administrative controls, such as worker rotation, more task variety, and increased rest

breaks; and using personal protective equipment, such as kneepads, vibration gloves, and similar devices.

Every year, one of the major issues pertaining to ergonomics is the lack of organizational ergonomics design (MacLeod, 2005). Human factor design does not involve just one type of ergonomics issue. Companies that wish to employ design ergonomics sometimes fail to consider all aspects of human factor design, which includes environmental and work design and physical and mental workload assessment. Also included in human factor design are lifting, stress, and posture, all of which can lead to workplace injuries, decreased productivity, and excessive sick days away from work (MacLeod, 2005).

Workers bring variability into the workplace. As a result, ergonomics can be an unpredictable and imprecise field, and there are no easy answers to solving ergonomic problems. An even larger issue is that companies are constrained by their perspective of ergonomics as an injury reduction program. Businesses may fail to grasp the benefits of ergonomics in terms of productivity and efficiency. Although some companies have attempted to tackle ergonomics, problems develop when they fail to maintain their programs (MacLeod, 2005).

Instrumentation

The instrument used to measure the discomfort in the participants was the Cornell Musculoskeletal Disorder (CMDQ; Hedge, Morimoto, & McCrobie, 1999), which was designed to measure the 7-day frequency, severity, and working ability of individuals based on WRMSDs on 20 parts of the body, including the neck, shoulder (right/left),

upper back, and upper arm (right/left). The CMDQ is based on a 5-point Likert scale that ranges from *never* (0) to *several times every day* (4), which indicates the frequency of discomfort.

Validity and Reliability

Standardization is needed in the analysis and recording of musculoskeletal symptoms. Otherwise, it is difficult to compare the results from different studies. This consideration was the main motive for a Nordic group to develop standardized questionnaires. Twenty-seven women in clerical work, who answered the questionnaire twice during a 3-week span, tested the reliability. Eighty-two women employed in electronic manufacturing, tested the validity.

Erdinç, Hot, and Özkaya (2008) provided evidence for the validity of the CMDQ by correlating the results with the Visual Analogue Scale (VAS), a highly reliable and valid instrument used to measure discomfort. Spearman's rank correlations coefficients assessed the relationships between the CMDQ and the VAS Kappa coefficients. found that The frequency in the responses of the CMDQ and the VAS were significantly related (Erdinç, Hot & Özkaya, 2008). In fact, the Kappa coefficients ranged from a low of .62 to a high of .92, indicating significant agreement between the frequency of responses on the CMDQ and the VAS instruments. In terms of Spearman's correlation coefficient, the researchers found that the correlations ranged from a low of .46 to a high of .83 across all body parts. Each of the correlations was significant at the .005 level of significance, indicating that the CMDQ was a valid tool.

Erdinç, Hot, and Özkaya, (2008), who used test-retest reliability, also determined the reliability of the CMDQ. This included calculating the Kappa coefficients for each of the frequency, severity, and interference scales of the CMDQ. They reported that the frequency scale had Kappa coefficients that ranged from a low of .56 to a high of .95, the severity scale had Kappa coefficients that ranged from a low of .59 to a high of .97, and the interference scale had Kappa coefficients that ranged from a low of .60 to a high of .94. Each of the frequency, severity, and interference scales had moderate to high test-retest reliability.

Operationalization of Variables

The operationalization of the variables is important because the type of analysis depends on the operational definitions of the variables. The frequency of WRMSD symptoms was the dependent variable in the analysis. The frequency of WRMSD symptoms operationalized a continuous variable based on the total number of symptoms that the participants experienced. Every symptom calculated a total score. This variable ranged on a scale from 0 to 20, which was based on the 20 locations on the body being measured.

The frequency of high-risk and handling tasks was the independent variable in the analysis. The frequency of high-risk and handling tasks operationalized a continuous variable based on the responses to the at-risk portion of the CMDQ. Based on the overall frequency to the responses to the questions regarding lifting boxes to sitting in one position, computed the frequency of these tasks.

The job category was the independent variable in the ANOVA. The job categories of the participants operationalized a categorical variable because there were three different positions: warehouse workers, stockroom clerks, and forklift drivers

The at-risk rating was the independent variable in the analysis. The at-risk rating was operationalized as a continuous variable based on the responses to the class rating of each participant. The frequency of WRMSDs was the independent variable. The frequency of WRMSDs operationalized a continuous variable based on the total score obtained from the CMDQ. The sum of scores provided an overall measurement of the frequency of WRMSDs. The final score ranged from zero to 80, with a higher score indicating a higher frequency of WRMSDs.

Pearson's Correlation Coefficient

Pearson's correlation coefficients addressed Hypotheses 1 and 3 to determine whether there was a statistically significant relationship between the length of time of the discomfort and the severity of the discomfort.

ANOVA

A one-way ANOVA addressed Hypothesis 2. The one-way ANOVA is a statistical method used to determine whether a predictor variable (i.e., warehouse worker, stockroom clerk, or forklift driver) had a significant impact on a single outcome variable (i.e., number of at-risk handling tasks). For analytical purposes, the outcome variable in the ANOVA is a continuous variable that can assume a wide range of values, whereas predictor variables are usually categorical in nature (Tabachnick & Fidell, 2001). This

means that the predictor variables are comprised of two or more specific levels or categories.

By including the positions of the participants in the one-way ANOVA, the results indicated whether the positions of the participants contributed to variations in the number of at-risk handling tasks. If one of the positions was significant, it explained some of the variation in the number of at-risk handling tasks (Tabachnick & Fidell, 2001). In other words, at least one of the positions was significantly different from one or all of the other positions regarding the number of at-risk handling tasks.

If there was a significant difference between the positions in the study, a post hoc test was conducted to determine which position resulted in more at-risk handling tasks when compared to the other positions. The post hoc test was the LSD test, whose purpose was to determine whether there is a significant difference among the four warehouse positions when compared with each other. Using a level of significance of .05 reduced the chances of making a Type I error, because the study made multiple comparisons among the positions in the study.

The LSD test determined whether there are significant differences among three or more independent populations. This study examined three groups of warehouse workers. Moore and McCabe (2006) commented, “The LSD procedure fixes the probability of a false rejection for each single pair of means being compared” (p. 744). Each of the comparisons in the independent groups in the sample tested at the .05 level of significance to determine whether there were significant differences among the job categories.

Research Questions and Hypotheses

1. How does the frequency of high-risk and handling tasks of warehouse personnel relate to WRMSD symptoms?
2. How are workload and WRMSDs different by job category among warehouse personnel (warehouse workers, stockroom clerks, and forklift drivers)?
3. What is the nature of the relationship between the at-risk classification rating and the frequency of WRMSDs among warehouse personnel?

Hypothesis 1

H_0: There is no relationship between the frequency of WRMSD symptoms in warehouse personnel and the frequency of high-risk and handling tasks that the workers perform.

H_a: There is a positive relationship between the frequency of WRMSD symptoms in warehouse personnel and the frequency of high-risk and handling tasks that the workers perform.

Hypothesis 2

H_0: There is no difference in the number of at-risk handling tasks performed by warehouse workers, stockroom clerks, and forklift drivers.

H_a: There is a significant difference in the number of at-risk handling tasks performed by warehouse workers, stockroom clerks, and forklift drivers.

Hypothesis 3

H_0: There is no relationship between the at-risk task rating and the frequency of WRMSDs among warehouse personnel**.**

H_a: There is a relationship between the at-risk task rating and the frequency of WRMSDs among warehouse personnel**.**

Test of Theory

Approximately 2 to 3 decades ago, ergonomics became widely used; since then, it has shared attention with the expanding use of technology in the workplace. Organizations are more concerned with the design of systems to help people carry out their work effectively.(Bridger,2003). Because of the increase in WRMSDs and other occupational injuries, employers face the responsibility of reducing the rate of these injuries.(Bridger,2003). Ergonomics may provide a solution to many of the problems in the workplace that organizations must address.

Summary

WRMSDs have become a major concern. Not implementing ergonomics properly in the workplace, serious issues will arise. For example, there may be disruptions in the workplace or in an organization's processes and procedures, and injuries may occur. When seeking solutions to WRMSDs, it is important to analyze the environment, ask questions, and seek guidance and input from those who are involved in the process. Perhaps the most efficient and effective way for organizations to reduce WRMSDs is to implement ergonomics, become knowledgeable about the workplace environment, and provide the best tools for employees.

The overall aim of the next chapter is to provide the results of the investigation into the association between the frequency of WRMSDs among able-bodied warehouse personnel and the factors hypothesized to be associated with this discomfort, such as the performance of manual handling tasks. Chapter 4 begins with an overview of the research questions, followed by an explanation of the descriptive statistics and the study variables.

CHAPTER 4: RESULTS

Introduction

The study concerned the frequency, discomfort, and work interference due to physical ailments among warehouse workers. This study addressed the following research questions:

The following research questions and hypotheses guided this research:

1. How does the frequency of high-risk and handling tasks of warehouse personnel relate to WRMSD symptoms?
2. How are workload and WRMSDs different by job category among warehouse personnel (warehouse workers, stockroom clerks, and forklift drivers)?
3. What is the nature of the relationship between the at-risk classification rating and the frequency of WRMSDs among warehouse personnel?

Hypothesis 1

H_0: There is no relationship between the frequency of WRMSD symptoms in warehouse personnel and the frequency of high-risk and handling tasks that the workers perform.

H_a: There is a positive relationship between the frequency of WRMSD symptoms in warehouse personnel and the frequency of high-risk and handling tasks that the workers perform.

Hypothesis 2

H_0: There is no difference in the number of at-risk handling tasks performed by warehouse workers, stockroom clerks, and forklift drivers.

H_a: There is a significant difference in the number of at-risk handling tasks performed by warehouse workers, stockroom clerks, and forklift drivers.

Hypothesis 3

H_0: There is no relationship between the at-risk task rating and the frequency of WRMSDs among warehouse personnel**.**

H_a: There is a relationship between the at-risk task rating and the frequency of WRMSDs among warehouse personnel**.**

A MANOVA conducted for each body part across the three research questions answered these questions. First, the descriptive statistics and frequency distributions of the sample and study variables are presented, followed by the MANOVAs conducted to determine which body part ailments were the most common across demographic group and selected work variables.

Descriptive Statistics of Sample and Study Variables

Description of Sample

Distributed questionnaires solicited 82 warehouse workers concerning their experience of physical ailments in the past week based on various demographic variables and work variables. Of these 82 participants, 71 completed and returned the questionnaires. Table 1 presents the demographics of the sample. Two thirds of the respondents were male (66%), and one third were female (33%). The majority of the

respondents were of African American ethnicity (48%). The rest were White (25%), Asian (16%), and Hispanic (9%). The average age was 34.9 (*SD* = 8.01, Skewness = .482, Kurtosis = -.389), with the youngest participant at age 21 and the oldest participant at age 53.

Table 1

Frequency Counts and Percentages for Demographic Variables

Variable	Frequency	Percent
Gender		
Male	48	66.2
Female	23	32.8
Ethnicity		
Asian	11	15.5
Black	34	47.9
Hispanic	6	8.5
White	18	25.4
Variable	*M*	*SD*
Age	34.9	8.01

Table 2 presents the frequency distributions for the work variables in the study. Most of the participants were warehouse workers (75%), with some forklift drivers (17%) and a few stockroom clerks (6%). Most of the participants were on a rotating shift (57%). Work activities that were very frequently done by the majority of participants include lifting boxes (78%), transferring pallets (75%), performing repetitive tasks (69%), and standing for long periods (56%). The activities included lifting objects from awkward positions, pushing or pulling objects, bending to pick up objects, lifting objects over the head, transferring objects without the use of equipment, and sitting in one position for protracted periods occurred at the lower frequent level.

Nearly all of the respondents use pallets all the time in moving equipment, and approximately two thirds of the participants received help from their coworkers to move equipment.

Table 2

Frequency Counts and Percentages for Work Variables

Variable	Frequency	Percentage
Job category		
Forklift driver		16.9
Stockroom clerk	12	5.6
Warehouse worker	4	74.6
Shift	53	
Permanent evenings		12.7
Permanent nights	18	25.4
Rotating days/evenings	32	45.1
Rotating days/nights	9	12.7
Frequency lifting boxes	9	
Very frequent		9.9
Frequent	7	5.6
Sometimes	53	74.6
Frequency transferring pallets	13	43.6
Very frequent	10	35.2
Frequent	34	
Frequency lifting object from awkward positions	32	47.9
Very frequent	33	45.1
Frequent	1	46.5
Sometimes	16	1.4
Frequency pushing or pulling objects		
Very frequent	21	
Frequent	25	
Frequency bending to pick up objects	19	
Very frequent	29	22.5
Frequent	1	1.4
Sometimes	40	29.6
Frequency performing repetitive tasks	2	26.8
Very frequent	25	46.5
Frequent	28	40.8
Sometimes	2	56.3
Frequency lifting objects over the head	5	32.4
Very frequent	12	2.8
Frequent	16	39.4
Sometimes	11	18.3
Frequency transferring equipment without the use of lifting equipment	13	17.6
Very frequent	5	23.7
Frequent	7	29.5
Sometimes		23.8
Frequency standing for a long period of time		17.4

Variable	Frequency	Percentage
Very frequent		
Frequent		
Sometimes		
Frequency sitting in one position for an extended period of time		
Very frequent		
Frequent		
Sometimes		
Variable	*M*	*SD*
Use of pallets in moving equipment	4.9	.35
Help received from coworkers in moving equipment	3.0	.52

Descriptions of Study Variables

This section presents the main study variables across affected body area. Table 3 present the frequency distributions for neck discomfort. Fewer than 10% of respondents reported neck discomfort in the previous week. In all cases, the pain was only slightly uncomfortable. More than 10% of the respondents reported slight interference with their work because of neck discomfort.

Table 3

Frequency Counts and Percentages for Neck Discomfort

Variable	Frequency	Percentage
Frequency of neck discomfort		
Never	1	1.4
1-2 times a week	66	93.0
3-4 times a week	4	5.6
Once everyday	1	1.4
Intensity of neck discomfort	0	0
N/A	65	91.5
Slightly uncomfortable	6	8.5
Moderately uncomfortable	0	0
Very uncomfortable	0	0
Work Interference due to neck discomfort	62	87.3
None at all	9	12.7
Slight interference	2	2.7
Substantial interference	0	0

Table 4 presents the frequency distributions for right shoulder discomfort. Fewer than 50% of the respondents reported some right shoulder discomfort in the previous

week. About a quarter of the respondents had slightly uncomfortable right shoulders and about 5% had moderate to very uncomfortable right shoulders. Close to 40% of the respondents reported slight to moderate interference with their work because of right shoulder discomfort.

Table 4

Frequency Counts and Percentages for Right Shoulder Discomfort

Variable	Frequency	Percentage
Frequency of right shoulder discomfort		
Never		
1-2 times a week	6	6.2
3-4 times a week	37	52.1
Once everyday	26	36.6
Intensity of right shoulder discomfort	5	7.0
N/A	47	66.2
Slightly uncomfortable	19	26.8
Moderately uncomfortable	4	5.6
Very uncomfortable	1	1.4
Work interference due to right shoulder discomfort	26	36.6
None at all	2	2.8
Slight interference	0	0
Substantial interference		

Table 5 presents the frequency distributions for left shoulder discomfort. The responses for left shoulder somewhat matched those for right shoulder discomfort, though there was slightly less discomfort in the left shoulder. About 40% of the respondents reported left shoulder discomfort in the previous week. For nearly one third of all respondents, there was slight to moderate intensity of discomfort. Again, more than one third of the respondents reported some level of interference with their work because of left shoulder discomfort.

Table 5

Frequency Counts and Percentages for Left Shoulder Discomfort

Variable	Frequency	Percentage
Frequency of left shoulder discomfort		
Never		
1-2 times a week	5	6.3
3-4 times a week	41	57.7
Once everyday	26	36.6
Intensity of left shoulder discomfort	4	5.6
N/A	50	70.4
Slightly uncomfortable	17	23.9
Moderately uncomfortable	4	5.6
Very uncomfortable	0	0
Work interference due to left shoulder discomfort	24	33.8
None at all	1	1.4
Slight interference	0	0
Substantial interference		

Table 6 presents the frequency distributions for right upper arm discomfort. About 20% of the respondents reported right upper arm discomfort in the previous week. In most cases, the pain was only slightly uncomfortable. Fewer than 20% of respondents reported interference with their work because of right upper arm discomfort.

Table 6

Frequency Counts and Percentages for Right Upper Arm Discomfort

Variable	Frequency	Percentage
Frequency of right upper arm discomfort		
Never		
1-2 times a week	29	27.9
3-4 times a week	56	78.9
Once everyday	14	19.7
Intensity of right upper arm discomfort	0	0
N/A	59	83.1
Slightly uncomfortable	11	15.5
Moderately uncomfortable	1	1.4
Very uncomfortable	0	0
Work Interference due to right upper arm discomfort	11	15.5
None at all	1	1.4
Slight interference	0	0
Substantial interference		

Table 7 presents the frequency distributions for left upper arm discomfort. There were fewer negative reports for left upper arm than for right upper arm discomfort in the sample. Just over 10% of the respondents reported left upper arm discomfort in the previous week. In nearly all cases, the pain was only slightly uncomfortable. About 13% of the respondents experienced some interference with their work because of left upper arm discomfort.

Table 7

Frequency Counts and Percentages for Left Upper Arm Discomfort

Variable	Frequency	Percentage
Frequency of left upper arm discomfort		
Never	11	15.7
1-2 times a week	58	81.7
3-4 times a week	13	18.3
Once everyday	0	0
Intensity of left upper arm discomfort		
N/A	62	87.3
Slightly uncomfortable	8	11.3
Moderately uncomfortable	1	1.4
Very uncomfortable	0	0
work interference due to left upper arm discomfort		
None at all	9	12.7
Slight interference	0	0
Substantial interference	0	0

Table 8 presents the frequency distributions for upper back discomfort. Nearly all participants noted some upper back discomfort in the previous week (81%). The intensity of pain experienced ran the gamut from slightly uncomfortable to very uncomfortable. In the same vein, nearly three quarters of the participants reported some interference with their work because of upper back discomfort.

Table 8

Frequency Counts and Percentages for Upper Back Discomfort

Variable	Frequency	Percentage
Frequency of upper back discomfort		
Never		
1-2 times a week	8	11.3
3-4 times a week	13	18.3
Once everyday	41	57.7
Intensity of upper back discomfort	15	21.1
N/A	30	42.3
Slightly uncomfortable	31	43.7
Moderately uncomfortable	9	12.7
Very uncomfortable	1	1.4
Work interference due to upper back discomfort	50	70.4
None at all	2	2.8
Slight interference	24	33.5
Substantial interference		

Table 9 presents the frequency distributions for lower back discomfort. Again, nearly all of the participants reported some lower back pain in the last week (76%). The intensity of pain experienced also extended across the range. However, about three quarters of the respondents found that their lower back pain interfered with their work, and nearly 10% of the sample reported that their lower back pain substantially interfered with their work. Though lower back pain was slightly less prevalent than upper back discomfort in the sample, it exerted greater interference on work among the sample.

Table 9

Frequency Counts and Percentages for Lower Back Discomfort

Variable	Frequency	Percentage
Frequency of lower back discomfort		
Never		
1-2 times a week	7	9.9
3-4 times a week	17	23.9
Once everyday	32	45.1
Intensity of lower back discomfort	20	28.2
N/A	30	42.3
Slightly uncomfortable	26	36.6
Moderately uncomfortable	14	19.7
Very uncomfortable	1	1.4
Work interference due to lower back discomfort	45	63.4
None at all	7	9.9
Slight interference	11	17.1
Substantial interference		

Table 10 presents the frequency distributions for right forearm discomfort. Fewer than 10% of the respondents reported right forearm discomfort in the previous week. In the few cases reported (4%), the pain was only slightly uncomfortable. Despite those low numbers, nearly 10% of the respondents reported slight interference with their work because of right forearm discomfort.

Table 10

Frequency Counts and Percentages for Right Forearm Discomfort

Variable	Frequency	Percentage
Frequency of right forearm discomfort		
Never		
1-2 times a week	8	11.3
3-4 times a week	65	91.5
Once everyday	6	8.5
Intensity of right forearm discomfort	0	0
N/A	68	95.8
Slightly uncomfortable	3	4.2
Moderately uncomfortable	0	0
Very uncomfortable	0	0
Work interference due to right forearm discomfort	8	11.3
None at all	0	0
Slight interference	4	5.7
Substantial interference		

Table 11 presents the frequency distributions for left forearm discomfort. Responses for the left forearm match those reported for right forearm discomfort. Fewer than 10% of the respondents reported left forearm discomfort in the previous week. In all cases, the pain was only slightly uncomfortable. Again, fewer than 10% of the respondents reported slight interference with their work because of left forearm discomfort.

Table 11

Frequency Counts and Percentages for Left Forearm Discomfort

Variable	Frequency	Percentage
Frequency of left forearm discomfort		
Never		
1-2 times a week	12	6.4
3-4 times a week	65	91.5
Once everyday	6	8.5
Intensity of left forearm discomfort	0	0
N/A	68	95.8
Slightly uncomfortable	3	4.2
Moderately uncomfortable	0	0
Very uncomfortable	0	0
Work interference due to left forearm discomfort	8	4.2
None at all	0	0
Slight interference	0	0
Substantial interference		

Table 12 presents the frequency distributions for right wrist discomfort. Nearly 20% of the respondents reported right wrist discomfort in the previous week. In most cases, the pain was only slightly uncomfortable. Just fewer than 20% of the respondents reported slight interference with their work because of right wrist discomfort.

Table 12

Frequency Counts and Percentages for Right Wrist Discomfort

Variable	Frequency	Percentage
Frequency of right wrist discomfort		
Never		
1-2 times a week	8	11.5
3-4 times a week	58	81.7
Once everyday	13	18.3
Intensity of right wrist discomfort	0	0
N/A	61	85.9
Slightly uncomfortable	9	12.7
Moderately uncomfortable	1	1.4
Very uncomfortable	0	0
Work interference due to right wrist discomfort	14	19.7
None at all	13	17.9
Slight interference	0	0
Substantial interference		

Table 13 presents the frequency distributions for left wrist discomfort. Fewer than 20% of the respondents reported left wrist discomfort in the previous week. In most cases, the pain was only slightly uncomfortable. Again, just fewer than 20% of the respondents reported slight interference with their work because of left wrist discomfort. There was slightly less left wrist discomfort than right wrist discomfort among the sample.

Table 13

Frequency Counts and Percentages for Left Wrist Discomfort

Variable	Frequency	Percentage
Frequency of left wrist discomfort		
Never		
1-2 times a week	5	7.7
3-4 times a week	59	83.1
Once everyday	12	16.9
Intensity of left wrist discomfort	0	0
N/A	61	85.9
Slightly uncomfortable	9	12.7
Moderately uncomfortable	1	1.4
Very uncomfortable	0	0
Work interference due to left wrist discomfort	13	18.3
None at all	8	10.3
Slight interference	2	2.7
Substantial interference		

Table 14 presents the frequency distributions for hip/buttock discomfort. Fewer than 10% of the respondents reported hip/buttock discomfort in the previous week. Although most of the respondents experienced only slight discomfort, some respondents reported that their hips/buttocks were moderately and even very uncomfortable. Just over 10% of the respondents reported some interference with their work because of hip/buttock discomfort.

Table 14

Frequency Counts and Percentages for Hip/Buttock Discomfort

Variable	Frequency	Percentage
Frequency of hip/buttock discomfort		
Never		
1-2 times a week	7	10.7
3-4 times a week	64	90.1
Once everyday	6	8.5
Intensity of hip/buttock discomfort	1	1.4
N/A	65	91.5
Slightly uncomfortable	4	5.6
Moderately uncomfortable	1	1.4
Very uncomfortable	1	1.4
Work interference due to hip/buttock discomfort	8	11.3
None at all	1	1.4
Slight interference	0	0
Substantial interference		

Table 15 presents the frequency distributions for right thigh discomfort. About 10% of the respondents reported right thigh discomfort in the previous week. In all cases, the pain was only slightly uncomfortable. These respondents also reported slight interference with their work because of right thigh discomfort.

Table 15

Frequency Counts and Percentages for Right Thigh Discomfort

Variable	Frequency	Percentage
Frequency of right thigh discomfort		
Never	0	0
1-2 times a week	62	87.3
3-4 times a week	9	12.7
Once everyday	0	0
Intensity of right thigh discomfort	67	94.4
N/A	4	5.6
Slightly uncomfortable	0	0
Moderately uncomfortable	0	0
Very uncomfortable		12.7
Work interference due to right thigh discomfort	9	4.9
None at all	3	0
Slight interference	0	
Substantial interference		

Table 16 presents the frequency distributions for left thigh discomfort. Approximately 10% of the respondents reported left thigh discomfort in the previous week. In all cases, the pain was only slightly uncomfortable. These respondents reported slight interference with their work because of left thigh discomfort. There were essentially the same levels of left and right thigh discomfort in the sample.

Table 16

Frequency Counts and Percentages for Left Thigh Discomfort

Variable	Frequency	Percentage
Frequency of left thigh discomfort		
Never		
1-2 times a week	0	0
3-4 times a week	62	87.3
Once everyday	9	12.7
Intensity of left thigh discomfort	0	0
N/A	68	95.8
Slightly uncomfortable	3	4.2
Moderately uncomfortable	0	0
Very uncomfortable	0	0
Work interference due to left thigh discomfort	10	14.1
None at all	0	0
Slight interference	0	0
Substantial interference		

Table 16 presents the frequency distributions for right knee discomfort. Nearly half of the respondents reported right knee discomfort in the previous week. In some cases, the pain was only slightly uncomfortable, but in about one sixth of these, the pain was moderately uncomfortable. More than half of the respondents reported some level of interference with their work because of right knee discomfort.

Table 17

Frequency Counts and Percentages for Right Knee Discomfort

Variable	Frequency	Percentage
Frequency of right knee discomfort		
Never		
1-2 times a week	7	9.3
3-4 times a week	36	49.3
Once everyday	30	42.3
Intensity of right knee discomfort	5	7.0
N/A	49	69.0
Slightly uncomfortable	18	25.4
Moderately uncomfortable	4	5.6
Very uncomfortable	0	0
Work interference due to right knee discomfort	36	50.7
None at all	3	4.2
Slight interference	3	4.2
Substantial interference		

Table 18 presents the frequency distributions for left knee discomfort. Again, nearly half of the respondents reported left knee discomfort in the previous week. Just as before, the pain was only slightly uncomfortable for some cases, but in about a sixth of these, the pain was moderately uncomfortable. More than half of the respondents reported some level of interference with their work because of right knee discomfort. There was about the same level of discomfort in right knee as in left knee among the participants.

Table 18

Frequency Counts and Percentages for Left Knee Discomfort

Variable	Frequency	Percentage
Frequency of left knee discomfort		
Never		
1-2 times a week	7	9.3
3-4 times a week	35	49.3
Once everyday	30	42.3
Intensity of left knee discomfort	5	7.0
N/A	49	69.0
Slightly uncomfortable	18	25.4
Moderately uncomfortable	4	5.6
Very uncomfortable	0	0
Work interference due to left knee discomfort	37	51.2
None at all	3	4.2
Slight interference	4	5.6
Substantial interference		

Table 19 presents the frequency distributions for right lower leg discomfort. Nearly 40% of the respondents reported right lower leg discomfort in the previous week. Less than 20% found it uncomfortable at all. Nevertheless, nearly 40% of the respondents reported some level of interference with their work because of right lower leg discomfort.

Table 19

Frequency Counts and Percentages for Right Lower Leg Discomfort

Variable	Frequency	Percentage
Frequency of right lower leg discomfort		
Never	4	5.9
1-2 times a week	43	60.6
3-4 times a week	24	33.8
Once everyday	3	4.2
Intensity of right lower leg discomfort	1	1.4
N/A	7	9.9
Slightly uncomfortable	5	7.0
Moderately uncomfortable	0	0
Very uncomfortable	43	60.6
Work interference due to right lower leg discomfort	3	4.2
None at all	1	1.4
Slight interference		
Substantial interference		

Table 20 presents the frequency distributions for left lower leg discomfort. Nearly 40% of the respondents reported left lower leg discomfort in the previous week. Again,

fewer than 20% found it uncomfortable at all. Nearly 40% of the respondents reported interference with their work because of left lower leg discomfort. Levels of discomfort were about the same between left and right lower leg discomfort among the respondents.

Table 20

Frequency Counts and Percentages for Left Lower Leg Discomfort

Variable	Frequency	Percentage
Frequency of left lower leg discomfort		
Never		
1-2 times a week	2	3.1
3-4 times a week	45	63.4
Once everyday	22	31.0
Intensity of left lower leg discomfort	4	5.6
N/A	58	81.7
Slightly uncomfortable	8	11.3
Moderately uncomfortable	5	7.0
Very uncomfortable	0	0
Work interference due to left lower leg discomfort	24	33.8
None at all	3	4.2
Slight interference	2	3.1
Substantial interference		

Group Differences in Physical Ailments

A MANOVA, run for each body part, determined which demographic group or work factor evinced higher frequencies of, intensities of, and interference from discomfort in each body part. The dependent variables were re-coded according to their ordinal position. Frequency of discomfort was re-coded as follows: never - 0, 1-2 times a week - 1, 3-4 times a week - 2, once everyday - 3. Intensity of discomfort was re-coded as follows: n/a - 0, slightly uncomfortable - 1, moderately uncomfortable - 2, very uncomfortable - 3. Work interference due to discomfort was recorded as follows: none at all - 0, slight interference - 1, substantial interference - 2. Demographic variables and work variables were included as independent variables in the between-groups model.

Tables 21 and 22 present the multivariate effects and univariate effects for neck discomfort. There was a significant difference in neck discomfort across the job categories with F (9, 68.295) = 2.348, p < .05, lifting boxes with F (6, 56) = 3.162, p < .05 and standing for long periods with F (6, 56) = 2.938, p < .05. Specifically, the forklift drivers and stockroom workers with F (3, 30) = 3.513, p < .05, as well as the participants who very frequently stood for long periods with F (2, 30) = 9.573, p < .05, had higher frequencies of neck discomfort. In contrast, the participants who lifted boxes only sometimes had the lowest levels of neck discomfort with F (2, 30) = 3.33, p < .05.

Table 21

Multivariate Tests for Neck Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.023	.223	3.000	28.000	.880
	Wilks' lambda	.977	.223	3.000	28.000	.880
	Hotelling's trace	.024	.223	3.000	28.000	.880
	Roy's largest root	.024	.223	3.000	28.000	.880
Gender	Pillai's trace	.109	.557	6.000	58.000	.763
	Wilks' lambda	.892	.548	6.000	56.000	.769
	Hotelling's trace	.120	.539	6.000	54.000	.776
	Roy's largest root	.110	1.062	3.000	29.000	.380
Job category	Pillai's trace	.550	2.243	9.000	90.000	.026* Table 25 Cont'd
	Wilks' lambda	.519	2.348	9.000	68.295	.023* Table 25 Cont'd
	Hotelling's trace	.796	2.358	9.000	80.000	.020*
	Roy's largest root	.565	5.645	3.000	30.000	.003*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Shift	Pillai's trace	.496	1.484	12.000	90.000	.145
	Wilks' lambda	.558	1.529	12.000	74.373	.133
	Hotelling's trace	.698	1.551	12.000	80.000	.124
	Roy's largest root	.533	3.999	4.000	30.000	.010*
Use of Pallets to move equipment	Pillai's trace	.236	1.296	6.000	58.000	.274
	Wilks' lambda	.767	1.321	6.000	56.000	.263
	Hotelling's trace	.298	1.341	6.000	54.000	.255
	Roy's largest root	.280	2.711	3.000	29.000	.063
Help received from coworkers to move equipment	Pillai's trace	.241	.872	9.000	90.000	.553
	Wilks' lambda	.764	.887	9.000	68.295	.542
	Hotelling's trace	.302	.896	9.000	80.000	.533
	Roy's largest root	.280	2.804	3.000	30.000	.057
Lifting boxes	Pillai's trace	.493	3.162	6.000	58.000	.009*
	Wilks' lambda	.558	3.162	6.000	56.000	.010*
	Hotelling's trace	.701	3.156	6.000	54.000	.010*
	Roy's largest root	.529	5.114	3.000	29.000	.006*
Transferring pallets from one location to another	Pillai's trace	.110	1.148	3.000	28.000	.347
	Wilks' lambda	.890	1.148	3.000	28.000	.347
	Hotelling's trace	.123	1.148	3.000	28.000	.347
	Roy's largest root	.123	1.148	3.000	28.000	.347 Table 25 Cont'd
Lifting objects from an awkward position	Pillai's trace	.354	2.078	6.000	58.000	.070
	Wilks' lambda	.657	2.180	6.000	56.000	.058
	Hotelling's trace	.505	2.271	6.000	54.000	.050*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Roy's largest root	.469	4.530	3.000	29.000	.010*
Pushing or pulling objects	Pillai's trace	.110	1.150	3.000	28.000	.346
	Wilks' lambda	.890	1.150	3.000	28.000	.346
	Hotelling's trace	.123	1.150	3.000	28.000	.346
	Roy's largest root	.123	1.150	3.000	28.000	.346
Bending to pick up an object	Pillai's trace	.111	1.164	3.000	28.000	.341
	Wilks' lambda	.889	1.164	3.000	28.000	.341
	Hotelling's trace	.125	1.164	3.000	28.000	.341
	Roy's largest root	.125	1.164	3.000	28.000	.341
Performing repetitive tasks	Pillai's trace	.025	.243	3.000	28.000	.865
	Wilks' lambda	.975	.243	3.000	28.000	.865
	Hotelling's trace	.026	.243	3.000	28.000	.865
	Roy's largest root	.026	.243	3.000	28.000	.865
Lifting objects over the head	Pillai's trace	.439	1.714	9.000	90.000	.097
	Wilks' lambda	.595	1.806	9.000	68.295	.083
	Hotelling's trace	.625	1.852	9.000	80.000	.071
	Roy's largest root	.522	5.216	3.000	30.000	.005*
Transferring equipment without the use of lifting equipment	Pillai's trace	.320	1.193	9.000	90.000	.309
	Wilks' lambda	.687	1.265	9.000	68.295	.272
	Hotelling's trace	.445	1.319	9.000	80.000	.241 Table 25 Cont'd
	Roy's largest root	.421	4.215	3.000	30.000	.0138 Table 25 Cont'd
Standing for a long period of time	Pillai's trace	.422	2.582	6.000	58.000	.028*
	Wilks' lambda	.578	2.938	6.000	56.000	.015*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Hotelling's trace	.729	3.279	6.000	54.000	.008*
	Roy's largest root	.729	7.043	3.000	29.000	.001*
Sitting in one position for an extended period of time	Pillai's trace	.251	1.385	6.000	58.000	.236
	Wilks' lambda	.762	1.359	6.000	56.000	.247
	Hotelling's trace	.296	1.331	6.000	54.000	.260
	Roy's largest root	.221	2.134	3.000	29.000	.118
Ethnicity	Pillai's trace	.136	.357	12.000	90.000	.975
	Wilks' lambda	.866	.348	12.000	74.373	.977
	Hotelling's trace	.153	.340	12.000	80.000	.979
	Roy's largest root	.137	1.028	4.000	30.000	.409

*$p < .05$

Table 22

Tests of Between-Subjects Effects for Neck Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	5.671	40	.142	2.334	.009
	Intensity	4.212	40	.105	2.466	.006
	Interference	5.504	40	.138	1.753	.057
Intercept	Frequency	.002	1	.002	.036	.851
	Intensity	.001	1	.001	.022	.884
	Interference	.024	1	.024	.310	.582
Gender	Frequency	.095	2	.048	.786	.465
	Intensity	.006	2	.003	.068	.934
	Interference	.023	2	.012	.149	.862
Job category	Frequency	.640	3	.213	3.513	.027*

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
	Intensity	.284	3	.095	2.219	.106
	Interference	.304	3	.101	1.289	.296
Shift	Frequency	.938	4	.234	3.859	.012*
	Intensity	.539	4	.135	3.156	.028*
	Interference	.722	4	.181	2.300	.082
Use of pallets to move equipment	Frequency	.062	2	.031	.507	.607
	Intensity	.196	2	.098	2.293	.118
	Interference	.044	2	.022	.282	.756
Help received from coworkers to move equipment	Frequency	.323	3	.108	1.771	.174
	Intensity	.213	3	.071	1.661	.196
	Interference	.029	3	.010	.125	.945
Lifting boxes	Frequency	.302	2	.151	2.483	.100
	Intensity	.284	2	.142	3.330	.049*
	Interference	.705	2	.352	4.487	.020*
Transferring pallets from one location to another	Frequency	.079	1	.079	1.306	.262
	Intensity	.001	1	.001	.027	.870
	Interference	.026	1	.026	.331	.569
Lifting objects from an awkward position	Frequency	.385	2	.193	3.170	.056
	Intensity	.230	2	.115	2.688	.084
	Interference	.008	2	.004	.048	.953
Pushing or pulling objects	Frequency	.071	1	.071	1.164	.289
	Intensity	.001	1	.001	.032	.859
	Interference	.057	1	.057	.722	.402

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Bending to pick up an object	Frequency	.186	1	.186	3.057	.091
	Intensity	.112	1	.112	2.626	.116
	Interference	.042	1	.042	.536	.470
Performing repetitive tasks	Frequency	.010	1	.010	.163	.690
	Intensity	.010	1	.010	.229	.636
	Interference	.004	1	.004	.053	.820
Lifting objects over the head	Frequency	.817	3	.272	4.481	.010*
	Intensity	.285	3	.095	2.226	.106
	Interference	.246	3	.082	1.046	.387
Transferring equipment without the use of lifting equipment	Frequency	.674	3	.225	3.701	.022*
	Intensity	.151	3	.050	1.182	.333
	Interference	.181	3	.060	.770	.520
Standing for a long period of time	Frequency	1.163	2	.581	9.573	.001*
	Intensity	.276	2	.138	3.228	.054
	Interference	.245	2	.122	1.559	.227
Sitting in one position for an extended period of time	Frequency	.374	2	.187	3.079	.061
	Intensity	.194	2	.097	2.277	.120
	Interference	.196	2	.098	1.251	.301
Ethnicity	Frequency	.032	4	.008	.132	.969
	Intensity	.034	4	.009	.199	.937
	Interference	.263	4	.066	.839	.511
Error	Frequency	1.822	30	.061		
	Intensity	1.281	30	.043		

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
	Interference	2.355	30	.079		
Total	Frequency	8.000	71			
	Intensity	6.000	71			
	Interference	9.000	71			
Corrected total	Frequency	7.493	70			
	Intensity	5.493	70			
	Interference	7.859	70			

*$p < .05$

Tables 23 and 24 present the multivariate effects and univariate effects for right shoulder discomfort. There was only a significant difference in right shoulder discomfort across frequency of bending to pick up objects. Specifically, those respondents who very frequently had to bend to pick up objects had more intense right shoulder discomfort and experienced more interference with their work.

Table 23

Multivariate Tests for Right Shoulder Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.118	1.201	3.000	27.000	.328
	Wilks' lambda	.882	1.201	3.000	27.000	.328
	Hotelling's trace	.133	1.201	3.000	27.000	.328
	Roy's largest root	.133	1.201	3.000	27.000	.328
Gender	Pillai's trace	.167	.852	6.000	56.000	.536
	Wilks' lambda	.836	.843	6.000	54.000	.542
	Hotelling's trace	.192	.833	6.000	52.000	.550
	Roy's largest root	.169	1.575	3.000	28.000	.218
Job category	Pillai's trace	.200	.692	9.000	87.000	.714
	Wilks' lambda	.810	.662	9.000	65.862	.740
	Hotelling's trace	.222	.632	9.000	77.000	.766
	Roy's largest root	.127	1.228	3.000	29.000	.318
Shift	Pillai's trace	.476	1.367	12.000	87.000	.197
	Wilks' lambda	.589	1.322	12.000	71.727	.225
	Hotelling's trace	.590	1.263	12.000	77.000	.258
	Roy's largest roo0074	.300	2.172	4.000	29.000	.097
Use of pallets to move equipment	Pillai's trace	.187	.963	6.000	56.000	.458
	Wilks' lambda	.814	.973	6.000	54.000	.452
	Hotelling's trace	.226	.979	6.000	52.000	.449
	Roy's largest root	.217	2.030	3.000	28.000	.132
Help received	Pillai's trace	.142	.480	9.000	87.000	.884

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
from coworkers to move equipment	Wilks' lambda	.863	.457	9.000	65.862	.898
	Hotelling's trace	.153	.437	9.000	77.000	.911
	Roy's largest root	.101	.973	3.000	29.000	.419
Lifting boxes	Pillai's trace	.090	.439	6.000	56.000	.850
	Wilks' lambda	.910	.432	6.000	54.000	.854
	Hotelling's trace	.098	.425	6.000	52.000	.859
	Roy's largest root	.095	.884	3.000	28.000	.461
Transferring pallets from one location to another	Pillai's trace	.232	2.723	3.000	27.000	.064
	Wilks' lambda	.768	2.723	3.000	27.000	.064
	Hotelling's trace	.303	2.723	3.000	27.000	.064
	Roy's largest root	.303	2.723	3.000	27.000	.064
Lifting objects from an awkward position	Pillai's trace	.219	1.147	6.000	56.000	.348
	Wilks' lambda	.782	1.180	6.000	54.000	.331
	Hotelling's trace	.279	1.209	6.000	52.000	.317
	Roy's largest root	.277	2.587	3.000	28.000	.073
Pushing or pulling objects	Pillai's trace	.176	1.923	3.000	27.000	.150
	Wilks' lambda	.824	1.923	3.000	27.000	.150
	Hotelling's trace	.214	1.923	3.000	27.000	.150
	Roy's largest root	.214	1.923	3.000	27.000	.150
Bending to pick up an object	Pillai's trace	.364	5.154	3.000	27.000	.006*
	Wilks' lambda	.636	5.154	3.000	27.000	.006*
	Hotelling's trace	.573	5.154	3.000	27.000	.006*
	Roy's largest root	.573	5.154	3.000	27.000	.006*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Performing repetitive tasks	Pillai's trace	.140	1.463	3.000	27.000	.247
	Wilks' lambda	.860	1.463	3.000	27.000	.247
	Hotelling's trace	.163	1.463	3.000	27.000	.247
	Roy's largest root	.163	1.463	3.000	27.000	.247
Lifting objects over the head	Pillai's trace	.244	.857	9.000	87.000	.567
	Wilks' lambda	.768	.839	9.000	65.862	.583
	Hotelling's trace	.287	.818	9.000	77.000	.602
	Roy's largest root	.213	2.063	3.000	29.000	.127
Transferring equipment without the use of lifting equipment	Pillai's trace	.265	.935	9.000	87.000	.499
	Wilks' lambda	.741	.960	9.000	65.862	.481
	Hotelling's trace	.342	.976	9.000	77.000	.467
	Roy's largest root	.319	3.080	3.000	29.000	.043*
Standing for a long period of time	Pillai's trace	.066	.318	6.000	56.000	.925
	Wilks' lambda	.934	.311	6.000	54.000	.929
	Hotelling's trace	.070	.304	6.000	52.000	.932
	Roy's largest root	.068	.639	3.000	28.000	.596
Sitting in one position for an extended period of time	Pillai's trace	.068	.328	6.000	56.000	.919
	Wilks' lambda	.933	.319	6.000	54.000	.924
	Hotelling's trace	.071	.309	6.000	52.000	.929
	Roy's largest root	.058	.545	3.000	28.000	.656
Ethnicity	Pillai's trace	.355	.973	12.000	87.000	.480
	Wilks' lambda	.681	.934	12.000	71.727	.519
	Hotelling's trace	.416	.890	12.000	77.000	.560

Effect	Value	*F*	Hypothesis *df*	Error *df*	Sig.
Roy's largest root	.202	1.462b	4.000	29.000	.239

*$p < .05$

Table 24

Tests of Between-Subjects Effects for Right Shoulder Discomfort

Source	DV	Type III Sum of Squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	20.935	40	.523	.850	.688
	Intensity	18.227	40	.456	1.023	.481
	Interference	10.277	40	.257	.686	.867
Intercept	Frequency	2.111	1	2.111	3.426	.074
	Intensity	.592	1	.592	1.329	.258
	Interference	.377	1	.377	1.007	.324
Gender	Frequency	2.590	2	1.295	2.102	.140
	Intensity	.666	2	.333	.748	.482
	Interference	1.140	2	.570	1.521	.235
Job category	Frequency	.441	3	.147	.239	.869
	Intensity	1.249	3	.416	.935	.437
	Interference	.404	3	.135	.360	.783
Shift	Frequency	3.659	4	.915	1.485	.232
	Intensity	3.637	4	.909	2.041	.115
	Interference	.948	4	.237	.633	.643
Use of pallets to move equipment	Frequency	.337	2	.168	.273	.763
	Intensity	.305	2	.153	.343	.713
	Interference	.030	2	.015	.039	.961
Help received from coworkers to move equipment	Frequency	1.631	3	.544	.883	.462
	Intensity	1.197	3	.399	.896	.455
	Interference	.633	3	.211	.563	.644
Lifting boxes	Frequency	.132	2	.066	.108	.898
	Intensity	.014	2	.007	.016	.984
	Interference	.707	2	.354	.944	.401
Transferring pallets from one location to another	Frequency	.131	1	.131	.212	.648
	Intensity	.877	1	.877	1.969	.171
	Interference	.027	1	.027	.072	.791
Lifting objects from an awkward position	Frequency	4.670	2	2.335	3.790	.034*
	Intensity	1.860	2	.930	2.089	.142
	Interference	2.285	2	1.142	3.049	.063
	Frequency	.002	1	.002	.003	.960

Source	DV	Type III Sum of Squares	*df*	*MS*	*F*	Sig.
Pushing or pulling objects	Intensity	1.071	1	1.071	2.404	.132
	Interference	.007	1	.007	.018	.893
	Frequency	1.392	1	1.392	2.260	.144
Bending to pick up an object	Intensity	5.190	1	5.190	11.653	.002*
	Interference	1.306	1	1.306	3.485	.072
Performing repetitive tasks	Frequency	2.624	1	2.624	4.260	.048*
	Intensity	.566	1	.566	1.271	.269
	Interference	.903	1	.903	2.411	.131
	Frequency	.724	3	.241	.392	.760
Lifting objects over the head	Intensity	1.357	3	.452	1.015	.400
	Interference	1.680	3	.560	1.494	.237
	Frequency	.862	3	.287	.466	.708
Transferring equipment without the use of lifting equipment	Intensity	1.586	3	.529	1.187	.332
	Interference	2.069	3	.690	1.841	.162
Standing for a long period of time	Frequency	.199	2	.099	.162	.852
	Intensity	.032	2	.016	.036	.965
	Interference	.400	2	.200	.534	.592
	Frequency	.622	2	.311	.505	.609
Sitting in one position for an extended period of time	Intensity	.627	2	.314	.704	.503
	Interference	.082	2	.041	.109	.897
Ethnicity	Frequency	2.742	4	.685	1.113	.370
	Intensity	1.027	4	.257	.576	.682
	Interference	1.903	4	.476	1.270	.304
Error	Frequency	17.865	29	.616		
	Intensity	12.916	29	.445		
	Interference	10.866	29	.375		
Total	Frequency	64.000	70			
	Intensity	44.000	70			
	Interference	34.000	70			
Corrected total	Frequency	38.800	69			
	Intensity	31.143	69			
	Interference	21.143	69			

*$p < .05$

Tables 25 and 26 present the multivariate effects and univariate effects for left shoulder discomfort. There was a significant difference in left shoulder discomfort across

frequency of moving pallets and frequency of bending to pick up objects. Specifically, those who very frequently moved pallets and those who frequently had to bend to pick up objects had greater intensity of left shoulder discomfort. Those participants who had to bend to lift objects seemed to experience the highest levels of shoulder discomfort.

Table 25

Multivariate Tests for Left Shoulder Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.068	.680	3.000	28.000	.572
	Wilks' lambda	.932	.680	3.000	28.000	.572
	Hotelling's trace	.073	.680	3.000	28.000	.572
	Roy's largest root	.073	.680	3.000	28.000	.572
Gender	Pillai's trace	.086	.436	6.000	58.000	.852
	Wilks' lambda	.914	.428	6.000	56.000	.857
	Hotelling's trace	.093	.420	6.000	54.000	.863
	Roy's largest root	.087	.842	3.000	29.000	.482
Job category	Pillai's trace	.272	.996	9.000	90.000	.449
	Wilks' lambda	.748	.961	9.000	68.295	.480
	Hotelling's trace	.310	.919	9.000	80.000	.513
	Roy's largest root	.179	1.787	3.000	30.000	.171
Shift	Pillai's trace	.461	1.362	12.000	90.000	.199
	Wilks' lambda	.594	1.349	12.000	74.373	.210
	Hotelling's trace	.593	1.317	12.000	80.000	.226
	Roy's largest root	.332	2.489	4.000	30.000	.064
Use of pallets to move equipment	Pillai's trace	.210	1.137	6.000	58.000	.353
	Wilks' lambda	.792	1.153	6.000	56.000	.345
	Hotelling's trace	.259	1.165	6.000	54.000	.338
	Roy's largest root	.246	2.374	3.000	29.000	.091
Help received from coworkers to move equipment	Pillai's trace	.231	.833	9.000	90.000	.588
	Wilks' lambda	.776	.833	9.000	68.295	.588
	Hotelling's trace	.280	.829	9.000	80.000	.591
	Roy's largest root	.246	2.463	3.000	30.000	.082
Lifting boxes	Pillai's trace	.087	.438	6.000	58.000	.850

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Wilks' lambda	.914	.428	6.000	56.000	.857
	Hotelling's trace	.093	.418	6.000	54.000	.864
	Roy's largest root	.080	.778	3.000	29.000	.516
Transferring pallets from one location to another	Pillai's trace	.299	3.972	3.000	28.000	.018*
	Wilks' lambda	.701	3.972	3.000	28.000	.018*
	Hotelling's trace	.426	3.972	3.000	28.000	.018*
	Roy's largest root	.426	3.972	3.000	28.000	.018*
Lifting objects from an awkward position	Pillai's trace	.124	.641	6.000	58.000	.697
	Wilks' lambda	.878	.627	6.000	56.000	.708
	Hotelling's trace	.136	.612	6.000	54.000	.719
	Roy's largest root	.111	1.071	3.000	29.000	.377
Pushing or pulling objects	Pillai's trace	.132	1.421	3.000	28.000	.258
	Wilks' lambda	.868	1.421	3.000	28.000	.258
	Hotelling's trace	.152	1.421	3.000	28.000	.258
	Roy's largest root	.152	1.421	3.000	28.000	.258
Bending to pick up an object	Pillai's trace	.319	4.382	3.000	28.000	.012*
	Wilks' lambda	.681	4.382	3.000	28.000	.012*
	Hotelling's trace	.469	4.382	3.000	28.000	.012*
	Roy's largest root	.469	4.382	3.000	28.000	.012*
Performing repetitive tasks	Pillai's trace	.076	.765	3.000	28.000	.523
	Wilks' lambda	.924	.765	3.000	28.000	.523
	Hotelling's trace	.082	.765	3.000	28.000	.523
	Roy's largest root	.082	.765	3.000	28.000	.523
Lifting objects over the head	Pillai's trace	.279	1.027	9.000	90.000	.425
	Wilks' lambda	.736	1.018	9.000	68.295	.435
	Hotelling's trace	.337	.999	9.000	80.000	.448
	Roy's largest root	.254	2.536	3.000	30.000	.076
Transferring equipment without the use of lifting equipment	Pillai's trace	.270	.991	9.000	90.000	.454
	Wilks' lambda	.734	1.027	9.000	68.295	.428
	Hotelling's trace	.356	1.054	9.000	80.000	.406
	Roy's largest root	.337	3.372	3.000	30.000	.031*
Standing for a long period of time	Pillai's trace	.064	.317	6.000	58.000	.926
	Wilks' lambda	.937	.310	6.000	56.000	.929
	Hotelling's trace	.067	.304	6.000	54.000	.932

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Roy's largest root	.065	.625	3.000	29.000	.605
Sitting in one position for an extended period of time	Pillai's trace	.143	.745	6.000	58.000	.616
	Wilks' lambda	.860	.731	6.000	56.000	.627
	Hotelling's trace	.159	.716	6.000	54.000	.638
	Roy's largest root	.131	1.270	3.000	29.000	.303
Ethnicity	Pillai's trace	.392	1.127	12.000	90.000	.349
	Wilks' lambda	.651	1.092	12.000	74.373	.379
	Hotelling's trace	.473	1.050	12.000	80.000	.413
	Roy's largest root	.243	1.822	4.000	30.000	.151

*$p < .05$

Table 26

Tests of Between-Subjects Effects for Left Shoulder Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	13.801	40	.345	.869	.665
	Intensity	15.245	40	.381	1.277	.245
	Interference	8.240	40	.206	.604	.932
Intercept	Frequency	.685	1	.685	1.723	.199
	Intensity	.295	1	.295	.989	.328
	Interference	.091	1	.091	.265	.610
Gender	Frequency	.293	2	.147	.369	.695
	Intensity	.721	2	.360	1.208	.313
	Interference	.023	2	.012	.034	.967
Job category	Frequency	.727	3	.242	.610	.614
	Intensity	1.477	3	.492	1.650	.199
	Interference	.751	3	.250	.733	.540
Shift	Frequency	1.309	4	.327	.824	.520
	Intensity	2.577	4	.644	2.159	.098
	Interference	.239	4	.060	.175	.949
Use of pallets to move equipment	Frequency	.324	2	.162	.408	.669
	Intensity	.371	2	.186	.622	.544
	Interference	.016	2	.008	.024	.977
Help received from coworkers to move equipment	Frequency	.638	3	.213	.536	.661
	Intensity	.281	3	.094	.314	.815
	Interference	.178	3	.059	.174	.913
Lifting boxes	Frequency	.144	2	.072	.181	.835
	Intensity	.233	2	.117	.391	.680

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
	Interference	.358	2	.179	.525	.597
	Frequency	.069	1	.069	.175	.679
Transferring pallets from one location to another	Intensity	1.149	1	1.149	3.852	.059
	Interference	.051	1	.051	.150	.701
Lifting objects from an awkward position	Frequency	1.064	2	.532	1.339	.277
	Intensity	.850	2	.425	1.424	.256
	Interference	.655	2	.328	.960	.394
	Frequency	.211	1	.211	.531	.472
Pushing or pulling objects	Intensity	1.114	1	1.114	3.733	.063
	Interference	.088	1	.088	.259	.615
	Frequency	1.328	1	1.328	3.343	.077
Bending to pick up an object	Intensity	3.659	1	3.659	12.261	.001*
	Interference	.920	1	.920	2.696	.111
Performing repetitive tasks	Frequency	.532	1	.532	1.339	.256
	Intensity	.008	1	.008	.026	.872
	Interference	.119	1	.119	.349	.559
	Frequency	.028	3	.009	.023	.995
Lifting objects over the head	Intensity	.595	3	.198	.664	.580
	Interference	.700	3	.233	.684	.569
	Frequency	.080	3	.027	.067	.977
Transferring equipment without the use of lifting equipment	Intensity	.679	3	.226	.759	.526
	Interference	1.045	3	.348	1.021	.397
Standing for a long period of time	Frequency	.032	2	.016	.040	.960
	Intensity	.304	2	.152	.509	.606
	Interference	.074	2	.037	.108	.898
	Frequency	1.047	2	.523	1.318	.283
Sitting in one position for an extended period of time	Intensity	1.117	2	.558	1.871	.171
	Interference	.439	2	.220	.643	.533
Ethnicity	Frequency	2.266	4	.566	1.426	.249
	Intensity	1.138	4	.284	.953	.447
	Interference	1.808	4	.452	1.325	.283
Error	Frequency	11.918	30	.397		
	Intensity	8.952	30	.298		
	Interference	10.239	30	.341		
Total	Frequency	42.000	71			
	Intensity	33.000	71			
	Interference	28.000	71			

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected Total	Frequency	25.718	70			
	Intensity	24.197	70			
	Interference	18.479	70			

*$p < .05$

Tables 27 and 28 present the multivariate effects and univariate effects for upper back discomfort. There was a significant difference in upper back discomfort across gender and a nearly significant difference in upper back discomfort across shift and use of pallets to move equipment. Specifically, the male respondents experienced greater interference with their work from upper back discomfort. Those respondents on rotating day/night and day/evening shifts had a lower frequency of upper back discomfort.

Table 27

Multivariate Tests for Upper Back Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.123	1.312	3.000	28.000	.290
	Wilks' lambda	.877	1.312	3.000	28.000	.290
	Hotelling's trace	.141	1.312	3.000	28.000	.290
	Roy's largest root	.141	1.312	3.000	28.000	.290
Gender	Pillai's trace	.395	2.376	6.000	58.000	.040*
	Wilks' lambda	.644	2.299	6.000	56.000	.047*
	Hotelling's trace	.494	2.222	6.000	54.000	.055
	Roy's largest root	.285	2.758	3.000	29.000	.060
Job Category	Pillai's trace	.420	1.627	9.000	90.000	.119
	Wilks' lambda	.613	1.689	9.000	68.295	.108
	Hotelling's trace	.577	1.711	9.000	80.000	.100
	Roy's largest root	.461	4.612	3.000	30.000	.009
Shift	Pillai's trace	.595	1.856	12.000	90.000	.051
	Wilks' lambda	.507	1.813	12.000	74.373	.061
	Hotelling's trace	.782	1.737	12.000	80.000	.074
	Roy's largest root	.422	3.163	4.000	30.000	.028
Use of pallets to	Pillai's trace	.360	2.124	6.000	58.000	.064

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
move equipment	Wilks' lambda	.669	2.082	6.000	56.000	.070
	Hotelling's trace	.453	2.038	6.000	54.000	.076
	Roy's largest root	.317	3.064	3.000	29.000	.044
Help received from coworkers to move equipment	Pillai's trace	.270	.988	9.000	90.000	.455
	Wilks' lambda	.743	.986	9.000	68.295	.459
	Hotelling's trace	.329	.976	9.000	80.000	.466
	Roy's largest root	.267	2.671	3.000	30.000	.065
Lifting boxes	Pillai's trace	.143	.744	6.000	58.000	.617
	Wilks' lambda	.857	.746	6.000	56.000	.615
	Hotelling's trace	.166	.747	6.000	54.000	.614
	Roy's largest root	.164	1.590	3.000	29.000	.213
Transferring pallets from one location to another	Pillai's trace	.049	.480	3.000	28.000	.699
	Wilks' lambda	.951	.480	3.000	28.000	.699
	Hotelling's trace	.051	.480	3.000	28.000	.699
	Roy's largest root	.051	.480	3.000	28.000	.699
Lifting objects from an awkward position	Pillai's trace	.268	1.493	6.000	58.000	.197
	Wilks' lambda	.750	1.444	6.000	56.000	.215
	Hotelling's trace	.310	1.394	6.000	54.000	.234
	Roy's largest root	.176	1.701	3.000	29.000	.189
Pushing or pulling objects	Pillai's trace	.144	1.571	3.000	28.000	.218
	Wilks' lambda	.856	1.571	3.000	28.000	.218
	Hotelling's trace	.168	1.571	3.000	28.000	.218
	Roy's largest root	.168	1.571	3.000	28.000	.218
Bending to pick up an object	Pillai's trace	.055	.540	3.000	28.000	.659
	Wilks' lambda	.945	.540	3.000	28.000	.659
	Hotelling's trace	.058	.540	3.000	28.000	.659
	Roy's largest root	.058	.540	3.000	28.000	.659
Performing repetitive tasks	Pillai's trace	.111	1.166	3.000	28.000	.340
	Wilks' lambda	.889	1.166	3.000	28.000	.340
	Hotelling's trace	.125	1.166	3.000	28.000	.340
	Roy's largest root	.125	1.166	3.000	28.000	.340
Lifting objects over the head	Pillai's trace	.307	1.141	9.000	90.000	.343
	Wilks' lambda	.715	1.119	9.000	68.295	.361
	Hotelling's trace	.367	1.086	9.000	80.000	.382

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Roy's largest root	.254	2.539	3.000	30.000	.075
Transferring equipment without the use of lifting equipment	Pillai's trace	.302	1.118	9.000	90.000	.358
	Wilks' lambda	.720	1.099	9.000	68.295	.376
	Hotelling's trace	.360	1.067	9.000	80.000	.396
	Roy's largest root	.237	2.371	3.000	30.000	.090
Standing for a long period of time	Pillai's trace	.247	1.361	6.000	58.000	.246
	Wilks' lambda	.764	1.345	6.000	56.000	.253
	Hotelling's trace	.295	1.327	6.000	54.000	.261
	Roy's largest root	.235	2.268	3.000	29.000	.102
Sitting in one position for an extended period of time	Pillai's trace	.249	1.374	6.000	58.000	.241
	Wilks' lambda	.758	1.390	6.000	56.000	.235
	Hotelling's trace	.312	1.402	6.000	54.000	.231
	Roy's largest root	.282	2.724	3.000	29.000	.062
Ethnicity	Pillai's trace	.417	1.210	12.000	90.000	.288
	Wilks' lambda	.614	1.255	12.000	74.373	.263
	Hotelling's trace	.579	1.287	12.000	80.000	.243
	Roy's largest root	.476	3.569	4.000	30.000	.017

*$p < .05$

Table 28

Tests of Between-Subjects Effects for Upper Back Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	21.580	40	.540	1.163	.337
	Intensity	24.759	40	.619	1.411	.165
	Interference	11.061	40	.277	1.414	.164
Intercept	Frequency	.000	1	.000	.001	.981
	Intensity	.812	1	.812	1.852	.184
	Interference	.443	1	.443	2.265	.143
Gender	Frequency	2.785	2	1.393	3.003	.065
	Intensity	2.017	2	1.008	2.299	.118
	Interference	1.545	2	.773	3.950	.030*
Job Category	Frequency	.194	3	.065	.140	.935
	Intensity	1.384	3	.461	1.052	.384
	Interference	1.065	3	.355	1.815	.166
Shift	Frequency	5.700	4	1.425	3.073	.031*

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
	Intensity	1.605	4	.401	.915	.468
	Interference	1.666	4	.417	2.129	.102
Use of pallets to move equipment	Frequency	2.507	2	1.253	2.702	.083
	Intensity	1.361	2	.680	1.552	.228
	Interference	.836	2	.418	2.137	.136
Help received from coworkers to move equipment	Frequency	3.302	3	1.101	2.373	.090
	Intensity	1.653	3	.551	1.256	.307
	Interference	.929	3	.310	1.583	.214
Lifting boxes	Frequency	.233	2	.116	.251	.779
	Intensity	1.223	2	.612	1.395	.263
	Interference	.759	2	.380	1.941	.161
Transferring pallets from one location to another	Frequency	.198	1	.198	.426	.519
	Intensity	.394	1	.394	.898	.351
	Interference	.007	1	.007	.035	.854
Lifting objects from an awkward position	Frequency	1.126	2	.563	1.214	.311
	Intensity	.502	2	.251	.572	.571
	Interference	.460	2	.230	1.175	.323
Pushing or pulling objects	Frequency	.035	1	.035	.076	.785
	Intensity	1.713	1	1.713	3.906	.057
	Interference	.200	1	.200	1.021	.320
Bending to pick up an object	Frequency	.307	1	.307	.661	.422
	Intensity	.000	1	.000	.001	.975
	Interference	.016	1	.016	.084	.774
Performing repetitive tasks	Frequency	.255	1	.255	.550	.464
	Intensity	.536	1	.536	1.221	.278
	Interference	.018	1	.018	.093	.762
Lifting objects over the head	Frequency	1.836	3	.612	1.320	.286
	Intensity	.938	3	.313	.713	.552
	Interference	.607	3	.202	1.035	.391
Transferring equipment without the use of lifting equipment	Frequency	2.378	3	.793	1.709	.186
	Intensity	.391	3	.130	.297	.827
	Interference	.412	3	.137	.703	.558
Standing for a long period of time	Frequency	2.113	2	1.056	2.278	.120
	Intensity	1.104	2	.552	1.258	.299
	Interference	.071	2	.036	.183	.834
Sitting in one	Frequency	.241	2	.120	.259	.773
	Intensity	1.128	2	.564	1.286	.291

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
position for an extended period of time	Interference	.867	2	.434	2.217	.127
	Frequency	5.119	4	1.280	2.760	.046*
Ethnicity	Intensity	1.250	4	.312	.712	.590
	Interference	1.528	4	.382	1.952	.127
	Frequency	13.913	30	.464		
Error	Intensity	13.157	30	.439		
	Interference	5.869	30	.196		
	Frequency	119.000	71			
Total	Intensity	76.000	71			
	Interference	58.000	71			
	Frequency	35.493	70			
Corrected total	Intensity	37.915	70			
	Interference	16.930	70			

*$p < .05$

Tables 29 and 30 present the multivariate effects and univariate effects for right upper arm discomfort. There was a significant difference in right upper arm discomfort across gender only. Specifically, the female respondents reported higher frequencies of right upper arm discomfort. No other significant findings were observed for right upper arm discomfort.

Table 29

Multivariate Tests for Right Upper Arm Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.374	5.569	3.000	28.000	.004
	Wilks' lambda	.626	5.569	3.000	28.000	.004
	Hotelling's trace	.597	5.569	3.000	28.000	.004
	Roy's largest root	.597	5.569	3.000	28.000	.004
Gender	Pillai's trace	.489	3.129	6.000	58.000	.010*
	Wilks' lambda	.525	3.553	6.000	56.000	.005*
	Hotelling's trace	.880	3.961	6.000	54.000	.002*
	Roy's largest root	.850	8.214	3.000	29.000	.000*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Job category	Pillai's trace	.245	.891	9.000	90.000	.537
	Wilks' lambda	.759	.911	9.000	68.295	.521
	Hotelling's trace	.312	.924	9.000	80.000	.509
	Roy's largest root	.292	2.924	3.000	30.000	.050
Shift	Pillai's trace	.183	.488	12.000	90.000	.917
	Wilks' lambda	.826	.466	12.000	74.373	.929
	Hotelling's trace	.201	.446	12.000	80.000	.939
	Roy's largest root	.131	.983	4.000	30.000	.431
Use of pallets to move equipment	Pillai's trace	.276	1.550	6.000	58.000	.178
	Wilks' lambda	.727	1.615	6.000	56.000	.160
	Hotelling's trace	.372	1.672	6.000	54.000	.146
	Roy's largest root	.360	3.476	3.000	29.000	.029*
Help received from coworkers to move equipment	Pillai's trace	.064	.218	9.000	90.000	.991
	Wilks' lambda	.937	.206	9.000	68.295	.993
	Hotelling's trace	.066	.197	9.000	80.000	.994
	Roy's largest root	.049	.491	3.000	30.000	.691
Lifting boxes	Pillai's trace	.105	.536	6.000	58.000	.779
	Wilks' lambda	.897	.519	6.000	56.000	.792
	Hotelling's trace	.112	.502	6.000	54.000	.804
	Roy's largest root	.076	.730	3.000	29.000	.542
Transferring pallets from one location to another	Pillai's trace	.079	.802	3.000	28.000	.503
	Wilks' lambda	.921	.802	3.000	28.000	.503
	Hotelling's trace	.086	.802	3.000	28.000	.503
	Roy's largest root	.086	.802	3.000	28.000	.503
Lifting objects from an awkward position	Pillai's trace	.078	.393	6.000	58.000	.880
	Wilks' lambda	.923	.384	6.000	56.000	.886
	Hotelling's trace	.083	.374	6.000	54.000	.892
	Roy's largest root	.071	.689	3.000	29.000	.566
Pushing or pulling objects	Pillai's trace	.041	.394	3.000	28.000	.758
	Wilks' lambda	.959	.394	3.000	28.000	.758
	Hotelling's trace	.042	.394	3.000	28.000	.758
	Roy's largest root	.042	.394	3.000	28.000	.758
Bending to pick up an object	Pillai's trace	.016	.155	3.000	28.000	.925
	Wilks' lambda	.984	.155	3.000	28.000	.925

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Hotelling's trace	.017	.155	3.000	28.000	.925
	Roy's largest root	.017	.155	3.000	28.000	.925
Performing repetitive tasks	Pillai's trace	.009	.083	3.000	28.000	.969
	Wilks' lambda	.991	.083	3.000	28.000	.969
	Hotelling's trace	.009	.083	3.000	28.000	.969
	Roy's largest root	.009	.083	3.000	28.000	.969
Lifting objects over the head	Pillai's trace	.100	.346	9.000	90.000	.957
	Wilks' lambda	.902	.328	9.000	68.295	.963
	Hotelling's trace	.106	.313	9.000	80.000	.969
	Roy's largest root	.058	.583	3.000	30.000	.630
Transferring equipment without the use of lifting equipment	Pillai's trace	.155	.546	9.000	90.000	.837
	Wilks' lambda	.848	.532	9.000	68.295	.847
	Hotelling's trace	.175	.518	9.000	80.000	.857
	Roy's largest root	.147	1.469	3.000	30.000	.243
Standing for a long period of time	Pillai's trace	.073	.365	6.000	58.000	.898
	Wilks' lambda	.928	.355	6.000	56.000	.904
	Hotelling's trace	.077	.345	6.000	54.000	.910
	Roy's largest root	.061	.593	3.000	29.000	.625
Sitting in one position for an extended period of time	Pillai's trace	.113	.580	6.000	58.000	.745
	Wilks' lambda	.889	.564	6.000	56.000	.757
	Hotelling's trace	.122	.548	6.000	54.000	.769
	Roy's largest root	.092	.894	3.000	29.000	.456
Ethnicity	Pillai's trace	.306	.851	12.000	90.000	.598
	Wilks' lambda	.701	.892	12.000	74.373	.558
	Hotelling's trace	.418	.930	12.000	80.000	.522
	Roy's largest root	.396	2.968	4.000	30.000	.035*

*$p < .05$

Table 30

Tests of Between-Subjects Effects for Right Upper Arm Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected Model	Frequency	12.490	40	.312	1.455	.144
	Intensity	8.665	40	.217	1.643	.080
	Interference	6.300	40	.158	.748	.807
Intercept	Frequency	2.059	1	2.059	9.590	.004
	Intensity	.522	1	.522	3.957	.056
	Interference	.005	1	.005	.025	.875
Gender	Frequency	3.815	2	1.908	8.887	.001*
	Intensity	.074	2	.037	.282	.756
	Interference	.112	2	.056	.265	.769
Job Category	Frequency	.353	3	.118	.549	.653
	Intensity	.709	3	.236	1.794	.170
	Interference	.080	3	.027	.126	.944
Shift	Frequency	.319	4	.080	.372	.827
	Intensity	.421	4	.105	.798	.536
	Interference	.724	4	.181	.859	.500
Use of pallets to move equipment	Frequency	.178	2	.089	.415	.664
	Intensity	.404	2	.202	1.533	.232
	Interference	.365	2	.183	.867	.430
Help received from coworkers to move equipment	Frequency	.127	3	.042	.198	.897
	Intensity	.048	3	.016	.121	.947
	Interference	.169	3	.056	.267	.849
Lifting boxes	Frequency	.157	2	.079	.367	.696
	Intensity	.140	2	.070	.531	.593
	Interference	.283	2	.142	.672	.518
Transferring pallets from one location to another	Frequency	.094	1	.094	.438	.513
	Intensity	.104	1	.104	.786	.382
	Interference	.047	1	.047	.225	.639
Lifting objects from an awkward position	Frequency	.106	2	.053	.247	.783
	Intensity	.043	2	.022	.164	.849
	Interference	.194	2	.097	.460	.636
Pushing or pulling objects	Frequency	.075	1	.075	.349	.559
	Intensity	.157	1	.157	1.192	.284
	Interference	.112	1	.112	.534	.471
Bending to pick up an	Frequency	.073	1	.073	.341	.564
	Intensity	.005	1	.005	.040	.843

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
object	Interference	.001	1	.001	.003	.955
Performing repetitive tasks	Frequency	.042	1	.042	.198	.660
	Intensity	.000	1	.000	.001	.974
	Interference	.015	1	.015	.071	.791
Lifting objects over the head	Frequency	.029	3	.010	.045	.987
	Intensity	.162	3	.054	.409	.748
	Interference	.237	3	.079	.375	.772
Transferring equipment without the use of lifting equipment	Frequency	.344	3	.115	.534	.662
	Intensity	.297	3	.099	.751	.530
	Interference	.133	3	.044	.211	.888
Standing for a long period of time	Frequency	.218	2	.109	.507	.607
	Intensity	.101	2	.051	.384	.685
	Interference	.081	2	.040	.192	.826
Sitting in one position for an extended period of time	Frequency	.193	2	.096	.449	.642
	Intensity	.123	2	.062	.467	.632
	Interference	.158	2	.079	.376	.690
Ethnicity	Frequency	.220	4	.055	.256	.904
	Intensity	.283	4	.071	.537	.710
	Interference	2.324	4	.581	2.759	.046*
Error	Frequency	6.439	30	.215		
	Intensity	3.955	30	.132		
	Interference	6.319	30	.211		
Total	Frequency	23.000	71			
	Intensity	15.000	71			
	Interference	15.000	71			
Corrected total	Frequency	18.930	70			
	Intensity	12.620	70			
	Interference	12.620	70			

*$p < .05$

Tables 31 and 32 present the multivariate effects and univariate effects for left upper arm discomfort. There were no significant group differences in left upper arm discomfort. However, there was a nearly significant effect for use of pallets to move equipment. As expected, the participants who did not use pallets had more intense levels of left upper arm discomfort.

Table 31

Multivariate Tests for Left Upper Arm Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.047	.465	3.000	28.000	.709
	Wilks' lambda	.953	.465	3.000	28.000	.709
	Hotelling's trace	.050	.465	3.000	28.000	.709
	Roy's largest root	.050	.465	3.000	28.000	.709
Gender	Pillai's trace	.071	.355	6.000	58.000	.904
	Wilks' lambda	.930	.344	6.000	56.000	.910
	Hotelling's trace	.074	.334	6.000	54.000	.916
	Roy's largest root	.057	.552	3.000	29.000	.651
Job category	Pillai's trace	.281	1.032	9.000	90.000	.421
	Wilks' lambda	.722	1.086	9.000	68.295	.384
	Hotelling's trace	.381	1.129	9.000	80.000	.353
	Roy's largest root	.371	3.706	3.000	30.000	.022*
Shift	Pillai's trace	.228	.617	12.000	90.000	.823
	Wilks' lambda	.787	.587	12.000	74.373	.846
	Hotelling's trace	.251	.559	12.000	80.000	.868
	Roy's largest root	.142	1.067	4.000	30.000	.390
Use of pallets to move equipment	Pillai's trace	.321	1.850	6.000	58.000	.105
	Wilks' lambda	.685	1.942	6.000	56.000	.090
	Hotelling's trace	.450	2.025	6.000	54.000	.078
	Roy's largest root	.428	4.137	3.000	29.000	.015*
Help received from coworkers to move equipment	Pillai's trace	.180	.639	9.000	90.000	.761
	Wilks' lambda	.823	.634	9.000	68.295	.764
	Hotelling's trace	.212	.628	9.000	80.000	.770
	Roy's largest root	.195	1.948	3.000	30.000	.143
Lifting boxes	Pillai's trace	.126	.650	6.000	58.000	.690
	Wilks' lambda	.876	.641	6.000	56.000	.697
	Hotelling's trace	.140	.631	6.000	54.000	.705
	Roy's largest root	.126	1.216	3.000	29.000	.322
Transferring pallets from one location to	Pillai's trace	.118	1.253	3.000	28.000	.310
	Wilks' lambda	.882	1.253	3.000	28.000	.310
	Hotelling's trace	.134	1.253	3.000	28.000	.310

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
another	Roy's largest root	.134	1.253	3.000	28.000	.310
Lifting objects from an awkward position	Pillai's trace	.200	1.076	6.000	58.000	.387
	Wilks' lambda	.806	1.065	6.000	56.000	.394
	Hotelling's trace	.234	1.052	6.000	54.000	.402
	Roy's largest root	.196	1.894	3.000	29.000	.153
Pushing or pulling objects	Pillai's trace	.080	.815	3.000	28.000	.497
	Wilks' lambda	.920	.815	3.000	28.000	.497
	Hotelling's trace	.087	.815	3.000	28.000	.497
	Roy's largest root	.087	.815	3.000	28.000	.497
Bending to pick up an object	Pillai's trace	.014	.130	3.000	28.000	.942
	Wilks' lambda	.986	.130	3.000	28.000	.942
	Hotelling's trace	.014	.130	3.000	28.000	.942
	Roy's largest root	.014	.130	3.000	28.000	.942
Performing repetitive tasks	Pillai's trace	.026	.247	3.000	28.000	.863
	Wilks' lambda	.974	.247	3.000	28.000	.863
	Hotelling's trace	.026	.247	3.000	28.000	.863
	Roy's largest root	.026	.247	3.000	28.000	.863
Lifting objects over the head	Pillai's trace	.106	.367	9.000	90.000	.948
	Wilks' lambda	.897	.348	9.000	68.295	.955
	Hotelling's trace	.112	.333	9.000	80.000	.962
	Roy's largest root	.067	.670	3.000	30.000	.577
Transferring equipment without the use of lifting equipment	Pillai's trace	.214	.770	9.000	90.000	.645
	Wilks' lambda	.792	.763	9.000	68.295	.651
	Hotelling's trace	.254	.754	9.000	80.000	.659
	Roy's largest root	.217	2.166	3.000	30.000	.113
Standing for a long period of time	Pillai's trace	.085	.428	6.000	58.000	.857
	Wilks' lambda	.915	.422	6.000	56.000	.861
	Hotelling's trace	.092	.416	6.000	54.000	.865
	Roy's largest root	.092	.886	3.000	29.000	.460
Sitting in one position for an extended period of time	Pillai's trace	.217	1.174	6.000	58.000	.333
	Wilks' lambda	.793	1.149	6.000	56.000	.346
	Hotelling's trace	.250	1.124	6.000	54.000	.361
	Roy's largest root	.187	1.803	3.000	29.000	.169
Ethnicity	Pillai's trace	.170	.451	12.000	90.000	.937

Effect	Value	*F*	Hypothesis *df*	Error *df*	Sig.
Wilks' lambda	.838	.428	12.000	74.373	.947
Hotelling's trace	.184	.408	12.000	80.000	.957
Roy's largest root	.108	.807	4.000	30.000	.531

*$p < .05$

Table 32

Tests of Between-Subjects Effects for Left Upper Arm Discomfort

Source	DV	Type III sum of squares	*Df*	*MS*	*F*	Sig.
Corrected model	Frequency	4.032	40	.101	.459	.989
	Intensity	7.366	40	.184	1.713	.064
	Interference	4.244	40	.106	.880	.651
Intercept	Frequency	.016	1	.016	.074	.788
	Intensity	.082	1	.082	.759	.391
	Interference	.008	1	.008	.067	.797
Gender	Frequency	.062	2	.031	.141	.869
	Intensity	.091	2	.046	.424	.659
	Interference	.101	2	.050	.418	.662
Job category	Frequency	.482	3	.161	.732	.541
	Intensity	.490	3	.163	1.520	.230
	Interference	.070	3	.023	.193	.900
Shift	Frequency	.371	4	.093	.422	.791
	Intensity	.149	4	.037	.347	.844
	Interference	.355	4	.089	.736	.574
Use of pallets to move equipment	Frequency	.218	2	.109	.497	.613
	Intensity	.798	2	.399	3.712	.036*
	Interference	.070	2	.035	.292	.749
Help received from coworkers to move equipment	Frequency	.039	3	.013	.059	.981
	Intensity	.218	3	.073	.675	.574
	Interference	.457	3	.152	1.265	.304
Lifting boxes	Frequency	.064	2	.032	.145	.866
	Intensity	.227	2	.113	1.055	.361
	Interference	.139	2	.070	.578	.567
Transferring pallets from one location to another	Frequency	.113	1	.113	.516	.478
	Intensity	.224	1	.224	2.085	.159
	Interference	.015	1	.015	.123	.728
Lifting objects from an awkward position	Frequency	.148	2	.074	.336	.717
	Intensity	.028	2	.014	.132	.876
	Interference	.472	2	.236	1.958	.159

Source	DV	Type III sum of squares	*Df*	*MS*	*F*	Sig.
Pushing or pulling objects	Frequency	.013	1	.013	.060	.809
	Intensity	.191	1	.191	1.778	.192
	Interference	.050	1	.050	.418	.523
Bending to pick up an object	Frequency	.019	1	.019	.085	.773
	Intensity	.006	1	.006	.054	.817
	Interference	.010	1	.010	.080	.779
Performing repetitive tasks	Frequency	.041	1	.041	.186	.670
	Intensity	.025	1	.025	.229	.635
	Interference	.007	1	.007	.054	.817
Lifting objects over the head	Frequency	.034	3	.011	.052	.984
	Intensity	.150	3	.050	.464	.709
	Interference	.151	3	.050	.419	.741
Transferring equipment without the use of lifting equipment	Frequency	.183	3	.061	.278	.841
	Intensity	.382	3	.127	1.183	.333
	Interference	.231	3	.077	.640	.595
Standing for a long period of time	Frequency	.088	2	.044	.201	.819
	Intensity	.131	2	.066	.610	.550
	Interference	.030	2	.015	.125	.883
Sitting in one position for an extended period of time	Frequency	.204	2	.102	.464	.633
	Intensity	.197	2	.099	.918	.410
	Interference	.511	2	.256	2.122	.137
Ethnicity	Frequency	.213	4	.053	.242	.912
	Intensity	.167	4	.042	.388	.815
	Interference	.258	4	.065	.536	.710
Error	Frequency	6.588	30	.220		
	Intensity	3.226	30	.108		
	Interference	3.615	30	.121		
Total	Frequency	13.000	71			
	Intensity	12.000	71			
	Interference	9.000	71			
Corrected total	Frequency	10.620	70			
	Intensity	10.592	70			
	Interference	7.859	70			

*$p < .05$

Tables 33 and 34 present the multivariate effects and univariate effects for lower back discomfort. There was a significant difference in lower back discomfort across

frequency of lifting boxes over one's head and frequency of sitting in one position for extended periods. Specifically, those respondents who very frequently raised objects over their heads had more intense lower back discomfort and experienced greater interference with work because of lower back discomfort. Furthermore, those respondents who very frequently sat in the same position for long periods also had more intense lower back discomfort and experienced greater interference with work.

Table 33

Multivariate Tests for Lower Back Discomfort

	Effect	Value	F	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.264	3.344	3.000	28.000	.033
	Wilks' lambda	.736	3.344	3.000	28.000	.033
	Hotelling's trace	.358	3.344	3.000	28.000	.033
	Roy's largest root	.358	3.344	3.000	28.000	.033
Gender	Pillai's trace	.078	.393	6.000	58.000	.880
	Wilks' lambda	.923	.381	6.000	56.000	.888
	Hotelling's trace	.082	.369	6.000	54.000	.895
	Roy's largest root	.060	.578	3.000	29.000	.634
Job category	Pillai's trace	.361	1.369	9.000	90.000	.214
	Wilks' lambda	.658	1.426	9.000	68.295	.195
	Hotelling's trace	.492	1.457	9.000	80.000	.178
	Roy's largest root	.425	4.246	3.000	30.000	.013*
Shift	Pillai's trace	.482	1.435	12.000	90.000	.165
	Wilks' lambda	.578	1.428	12.000	74.373	.173
	Hotelling's trace	.629	1.398	12.000	80.000	.184
	Roy's largest root	.375	2.815	4.000	30.000	.043*
Use of pallets to move equipment	Pillai's trace	.239	1.312	6.000	58.000	.266
	Wilks' lambda	.763	1.348	6.000	56.000	.252
	Hotelling's trace	.307	1.380	6.000	54.000	.240
	Roy's largest root	.296	2.857	3.000	29.000	.054
Help received from coworkers	Pillai's trace	.346	1.304	9.000	90.000	.246
	Wilks' lambda	.681	1.299	9.000	68.295	.254

Effect		Value	F	Hypothesis *df*	Error *df*	Sig.
to move equipment	Hotelling's trace	.429	1.273	9.000	80.000	.265
	Roy's largest root	.298	2.975	3.000	30.000	.047*
Lifting boxes	Pillai's trace	.089	.449	6.000	58.000	.843
	Wilks' lambda	.913	.434	6.000	56.000	.853
	Hotelling's trace	.093	.419	6.000	54.000	.863
	Roy's largest root	.055	.528	3.000	29.000	.667
Transferring pallets from one location to another	Pillai's trace	.042	.412	3.000	28.000	.745
	Wilks' lambda	.958	.412	3.000	28.000	.745
	Hotelling's trace	.044	.412	3.000	28.000	.745
	Roy's largest root	.044	.412	3.000	28.000	.745
Lifting objects from an awkward position	Pillai's trace	.221	1.202	6.000	58.000	.319
	Wilks' lambda	.790	1.165	6.000	56.000	.338
	Hotelling's trace	.251	1.128	6.000	54.000	.358
	Roy's largest root	.160	1.548	3.000	29.000	.223
Pushing or pulling objects	Pillai's trace	.079	.800	3.000	28.000	.504
	Wilks' lambda	.921	.800	3.000	28.000	.504
	Hotelling's trace	.086	.800	3.000	28.000	.504
	Roy's largest root	.086	.800	3.000	28.000	.504
Bending to pick up an object	Pillai's trace	.126	1.343	3.000	28.000	.280
	Wilks' lambda	.874	1.343	3.000	28.000	.280
	Hotelling's trace	.144	1.343	3.000	28.000	.280
	Roy's largest root	.144	1.343	3.000	28.000	.280
Performing repetitive tasks	Pillai's trace	.020	.186	3.000	28.000	.905
	Wilks' lambda	.980	.186	3.000	28.000	.905
	Hotelling's trace	.020	.186	3.000	28.000	.905
	Roy's largest root	.020	.186	3.000	28.000	.905
Lifting objects over the head	Pillai's trace	.499	1.997	9.000	90.000	.049*
	Wilks' lambda	.537	2.206	9.000	68.295	.032*
	Hotelling's trace	.794	2.353	9.000	80.000	.021*
	Roy's largest root	.704	7.037	3.000	30.000	.001*
Transferring equipment without the use of lifting equipment	Pillai's trace	.112	.388	9.000	90.000	.938
	Wilks' lambda	.891	.368	9.000	68.295	.946
	Hotelling's trace	.119	.352	9.000	80.000	.954
	Roy's largest root	.073	.731	3.000	30.000	.542

Effect		Value	F	Hypothesis *df*	Error *df*	Sig.
Standing for a long period of time	Pillai's trace	.202	1.086	6.000	58.000	.381
	Wilks' lambda	.806	1.065	6.000	56.000	.394
	Hotelling's trace	.232	1.042	6.000	54.000	.409
	Roy's largest root	.177	1.716	3.000	29.000	.186
Sitting in one position for an extended period of time	Pillai's trace	.361	2.131	6.000	58.000	.063
	Wilks' lambda	.661	2.144	6.000	56.000	.062
	Hotelling's trace	.478	2.150	6.000	54.000	.062
	Roy's largest root	.390	3.772	3.000	29.000	.021*
Ethnicity	Pillai's trace	.503	1.509	12.000	90.000	.135
	Wilks' lambda	.543	1.610	12.000	74.373	.107
	Hotelling's trace	.760	1.688	12.000	80.000	.085
	Roy's largest root	.632	4.738	4.000	30.000	.004

*$p < .05$

Table 34

Tests of Between-Subjects Effects for Lower Back Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	28.889	40	.722	1.405	.168
	Intensity	33.528	40	.838	2.147	.016
	Interference	17.635	40	.441	2.087	.019
Intercept	Frequency	.977	1	.977	1.901	.178
	Intensity	1.417	1	1.417	3.631	.066
	Interference	2.121	1	2.121	10.044	.004
Gender	Frequency	.748	2	.374	.727	.492
	Intensity	.376	2	.188	.482	.622
	Interference	.063	2	.032	.150	.861
Job category	Frequency	.843	3	.281	.547	.654
	Intensity	1.006	3	.335	.859	.473
	Interference	1.341	3	.447	2.116	.119
Shift	Frequency	5.418	4	1.355	2.635	.054
	Intensity	1.462	4	.365	.936	.456
	Interference	2.074	4	.518	2.454	.067
Use of pallets to move equipment	Frequency	.228	2	.114	.222	.803
	Intensity	.613	2	.307	.786	.465
	Interference	.809	2	.405	1.916	.165
Help received from coworkers to move	Frequency	2.235	3	.745	1.449	.248
	Intensity	1.309	3	.436	1.117	.358

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
equipment	Interference	.782	3	.261	1.234	.315
Lifting boxes	Frequency	.128	2	.064	.125	.883
	Intensity	.542	2	.271	.694	.507
	Interference	.253	2	.126	.599	.556
Transferring pallets from one location to another	Frequency	.339	1	.339	.659	.423
	Intensity	.002	1	.002	.006	.941
	Interference	.199	1	.199	.941	.340
Lifting objects from an awkward position	Frequency	1.987	2	.993	1.932	.162
	Intensity	.082	2	.041	.105	.900
	Interference	.352	2	.176	.833	.445
Pushing or pulling objects	Frequency	.549	1	.549	1.068	.310
	Intensity	.151	1	.151	.388	.538
	Interference	.017	1	.017	.081	.778
Bending to pick up an object	Frequency	1.720	1	1.720	3.346	.077
	Intensity	.666	1	.666	1.707	.201
	Interference	.244	1	.244	1.156	.291
Performing repetitive tasks	Frequency	.010	1	.010	.020	.889
	Intensity	.123	1	.123	.315	.579
	Interference	.088	1	.088	.417	.523
Lifting objects over the head	Frequency	1.035	3	.345	.671	.576
	Intensity	3.033	3	1.011	2.590	.071
	Interference	3.574	3	1.191	5.641	.003*
Transferring equipment without the use of lifting equipment	Frequency	.058	3	.019	.038	.990
	Intensity	.717	3	.239	.612	.612
	Interference	.202	3	.067	.318	.812
Standing for a long period of time	Frequency	.871	2	.435	.847	.439
	Intensity	1.123	2	.561	1.438	.253
	Interference	.584	2	.292	1.383	.266
Sitting in one position for an extended period of time	Frequency	1.079	2	.540	1.050	.362
	Intensity	.540	2	.270	.692	.508
	Interference	1.587	2	.793	3.756	.035*
Ethnicity	Frequency	3.612	4	.903	1.757	.164
	Intensity	6.091	4	1.523	3.901	.011*
	Interference	2.588	4	.647	3.063	.031*
Error	Frequency	15.421	30	.514		
	Intensity	11.711	30	.390		
	Interference	6.337	30	.211		

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Total	Frequency	130.000	71			
	Intensity	91.000	71			
	Interference	73.000	71			
Corrected total	Frequency	44.310	70			
	Intensity	45.239	70			
	Interference	23.972	70			

*$p < .05$

Tables 35 and 36 present the multivariate effects and univariate effects for right forearm discomfort. There was a significant difference in right forearm discomfort across the use of pallets to move equipment, receiving help from coworkers, transferring pallets from one location to another, and transferring equipment without pallets. Frequency of lifting boxes also was a nearly significant effect.

The participants who made more use of pallets to move equipment and received more help from coworkers experienced more work interference because of right forearm discomfort. Work interference also was higher among those respondents who lifted boxes less frequently and those who used lifting equipment to transfer equipment more often. The participants who less frequently transferred pallets from one location to another had greater discomfort across the board. They had more frequent and more intense right forearm discomfort that interfered more with their work.

Table 35

Multivariate Tests for Right Forearm Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.132	1.416	3.000	28.000	.259
	Wilks' lambda	.868	1.416	3.000	28.000	.259
	Hotelling's trace	.152	1.416	3.000	28.000	.259
	Roy's largest root	.152	1.416	3.000	28.000	.259
Gender	Pillai's trace	.222	1.210	6.000	58.000	.314
	Wilks' lambda	.789	1.176	6.000	56.000	.332
	Hotelling's trace	.254	1.142	6.000	54.000	.351
	Roy's largest root	.171	1.658	3.000	29.000	.198
Job category	Pillai's trace	.437	1.704	9.000	90.000	.099
	Wilks' lambda	.581	1.897	9.000	68.295	.067
	Hotelling's trace	.691	2.048	9.000	80.000	.044*
	Roy's largest root	.645	6.454	3.000	30.000	.002*
Shift	Pillai's trace	.244	.665	12.000	90.000	.780
	Wilks' lambda	.770	.643	12.000	74.373	.799
	Hotelling's trace	.280	.622	12.000	80.000	.818
	Roy's largest root	.189	1.419	4.000	30.000	.252
Use of pallets to move equipment	Pillai's trace	.392	2.353	6.000	58.000	.042*
	Wilks' lambda	.642	2.312	6.000	56.000	.046*
	Hotelling's trace	.504	2.267	6.000	54.000	.050*
	Roy's largest root	.355	3.429	3.000	29.000	.030*
Help received from coworkers to move equipment	Pillai's trace	.593	2.462	9.000	90.000	.015*
	Wilks' lambda	.457	2.883	9.000	68.295	.006*
	Hotelling's trace	1.081	3.204	9.000	80.000	.002*
	Roy's largest root	.970	9.704	3.000	30.000	.000*
Lifting boxes	Pillai's trace	.337	1.961	6.000	58.000	.086
	Wilks' lambda	.677	2.012	6.000	56.000	.079
	Hotelling's trace	.457	2.057	6.000	54.000	.074
	Roy's largest root	.406	3.926	3.000	29.000	.018*
Transferring pallets from one location to	Pillai's trace	.304	4.074	3.000	28.000	.016*
	Wilks' lambda	.696	4.074	3.000	28.000	.016*
	Hotelling's trace	.437	4.074	3.000	28.000	.016*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
another	Roy's largest root	.437	4.074	3.000	28.000	.016*
Lifting objects from an awkward position	Pillai's trace	.084	.424	6.000	58.000	.860
	Wilks' lambda	.917	.416	6.000	56.000	.865
	Hotelling's trace	.090	.407	6.000	54.000	.871
	Roy's largest root	.082	.796	3.000	29.000	.506
Pushing or pulling objects	Pillai's trace	.042	.406	3.000	28.000	.750
	Wilks' lambda	.958	.406	3.000	28.000	.750
	Hotelling's trace	.044	.406	3.000	28.000	.750
	Roy's largest root	.044	.406	3.000	28.000	.750
Bending to pick up an object	Pillai's trace	.083	.844	3.000	28.000	.481
	Wilks' lambda	.917	.844	3.000	28.000	.481
	Hotelling's trace	.090	.844	3.000	28.000	.481
	Roy's largest root	.090	.844	3.000	28.000	.481
Performing repetitive tasks	Pillai's trace	.096	.995	3.000	28.000	.409
	Wilks' lambda	.904	.995	3.000	28.000	.409
	Hotelling's trace	.107	.995	3.000	28.000	.409
	Roy's largest root	.107	.995	3.000	28.000	.409
Lifting objects over the head	Pillai's trace	.404	1.555	9.000	90.000	.141
	Wilks' lambda	.618	1.660	9.000	68.295	.116
	Hotelling's trace	.584	1.729	9.000	80.000	.096
	Roy's largest root	.519	5.186	3.000	30.000	.005*
Transferring equipment without the use of lifting equipment	Pillai's trace	.614	2.574	9.000	90.000	.011*
	Wilks' lambda	.479	2.682	9.000	68.295	.010*
	Hotelling's trace	.904	2.679	9.000	80.000	.009*
	Roy's largest root	.656	6.563	3.000	30.000	.002*
Standing for a long period of time	Pillai's trace	.167	.882	6.000	58.000	.514
	Wilks' lambda	.833	.893	6.000	56.000	.506
	Hotelling's trace	.200	.902	6.000	54.000	.500
	Roy's largest root	.200	1.934	3.000	29.000	.146
Sitting in one position for an extended period of time	Pillai's trace	.249	1.372	6.000	58.000	.241
	Wilks' lambda	.754	1.413	6.000	56.000	.226
	Hotelling's trace	.322	1.449	6.000	54.000	.213
	Roy's largest root	.310	2.994	3.000	29.000	.047*
Ethnicity	Pillai's trace	.295	.817	12.000	90.000	.632

Effect	Value	*F*	Hypothesis *df*	Error *df*	Sig.
Wilks' lambda	.726	.796	12.000	74.373	.653
Hotelling's trace	.348	.772	12.000	80.000	.677
Roy's largest root	.233	1.746b	4.000	30.000	.166

*$p < .05$

Table 36

Tests of Between-Subjects Effects for Right Forearm Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	3.946	40	.099	1.914	.034
	Intensity	2.230	40	.056	2.603	.004
	Interference	6.053	40	.151	4.343	.000
Intercept	Frequency	.055	1	.055	1.058	.312
	Intensity	.033	1	.033	1.553	.222
	Interference	.006	1	.006	.171	.682
Gender	Frequency	.131	2	.066	1.271	.295
	Intensity	.091	2	.045	2.122	.137
	Interference	.118	2	.059	1.693	.201
Job category	Frequency	.114	3	.038	.737	.538
	Intensity	.256	3	.085	3.986	.017*
	Interference	.179	3	.060	1.717	.185
Shift	Frequency	.084	4	.021	.406	.803
	Intensity	.060	4	.015	.695	.602
	Interference	.144	4	.036	1.034	.406
Use of pallets to move equipment	Frequency	.127	2	.064	1.236	.305
	Intensity	.055	2	.027	1.275	.294
	Interference	.230	2	.115	3.304	.050*
Help received from coworkers to move equipment	Frequency	.121	3	.040	.782	.514
	Intensity	.075	3	.025	1.172	.337
	Interference	.915	3	.305	8.759	.000*
Lifting boxes	Frequency	.182	2	.091	1.765	.189
	Intensity	.057	2	.029	1.335	.278
	Interference	.415	2	.207	5.950	.007*
Transferring pallets from one location to another	Frequency	.278	1	.278	5.391	.027*
	Intensity	.200	1	.200	9.323	.005*
	Interference	.313	1	.313	8.997	.005*
Lifting objects from an awkward position	Frequency	.030	2	.015	.287	.753
	Intensity	.004	2	.002	.095	.910
	Interference	.073	2	.037	1.048	.363

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Pushing or pulling objects	Frequency	.005	1	.005	.089	.767
	Intensity	.026	1	.026	1.233	.276
	Interference	.021	1	.021	.593	.447
Bending to pick up an object	Frequency	6.281E-8	1	6.281E-8	.000	.999
	Intensity	.050	1	.050	2.351	.136
	Interference	.006	1	.006	.176	.678
Performing repetitive tasks	Frequency	.017	1	.017	.334	.567
	Intensity	.008	1	.008	.394	.535
	Interference	.062	1	.062	1.770	.193
Lifting objects over the head	Frequency	.136	3	.045	.877	.464
	Intensity	.127	3	.042	1.970	.140
	Interference	.527	3	.176	5.041	.006*
Transferring equipment without the use of lifting equipment	Frequency	.227	3	.076	1.466	.244
	Intensity	.258	3	.086	4.008	.016*
	Interference	.186	3	.062	1.778	.173
Standing for a long period of time	Frequency	.091	2	.045	.881	.425
	Intensity	.005	2	.003	.126	.882
	Interference	.092	2	.046	1.315	.284
Sitting in one position for an extended period of time	Frequency	.246	2	.123	2.381	.110
	Intensity	.043	2	.022	1.013	.375
	Interference	3.014E-5	2	1.507E-5	.000	1.000
Ethnicity	Frequency	.096	4	.024	.467	.760
	Intensity	.087	4	.022	1.017	.414
	Interference	.240	4	.060	1.719	.172
Error	Frequency	1.547	30	.052		
	Intensity	.643	30	.021		
	Interference	1.045	30	.035		
Total	Frequency	6.000	71			
	Intensity	3.000	71			
	Interference	8.000	71			
Corrected total	Frequency	5.493	70			
	Intensity	2.873	70			
	Interference	7.099	70			

*$p < .05$

Tables 37 and 38 present the multivariate effects and univariate effects for left forearm discomfort. Findings for left forearm discomfort matched right forearm discomfort. There was a significant difference in left forearm discomfort across use of pallets to move equipment, receiving help from coworkers, transferring pallets from one location to another and transferring equipment without pallets. Frequency of lifting boxes was, once again, a nearly significant effect. Just as observed with right forearm discomfort, the participants who made more use of pallets to move equipment and received more help from coworkers experienced more work interference because of left forearm discomfort. Work interference also was higher among those who lifted boxes less frequently and those who used lifting equipment to transfer equipment more often. The participants who less frequently transferred pallets from one location to another had more frequent and more intense right forearm discomfort that interfered more with their work.

Table 37

Multivariate Tests for Left Forearm Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.132	1.416	3.000	28.000	.259
	Wilks' lambda	.868	1.416	3.000	28.000	.259
	Hotelling's trace	.152	1.416	3.000	28.000	.259
	Roy's largest root	.152	1.416	3.000	28.000	.259
Gender	Pillai's trace	.222	1.210	6.000	58.000	.314
	Wilks' lambda	.789	1.176	6.000	56.000	.332
	Hotelling's trace	.254	1.142	6.000	54.000	.351
	Roy's largest root	.171	1.658	3.000	29.000	.198
Job category	Pillai's trace	.437	1.704	9.000	90.000	.099
	Wilks' lambda	.581	1.897	9.000	68.295	.067
	Hotelling's trace	.691	2.048	9.000	80.000	.044*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Roy's largest root	.645	6.454	3.000	30.000	.002*
Shift	Pillai's trace	.244	.665	12.000	90.000	.780
	Wilks' lambda	.770	.643	12.000	74.373	.799
	Hotelling's trace	.280	.622	12.000	80.000	.818
	Roy's largest root	.189	1.419	4.000	30.000	.252
Use of pallets to move equipment	Pillai's trace	.392	2.353	6.000	58.000	.042*
	Wilks' lambda	.642	2.312	6.000	56.000	.046*
	Hotelling's trace	.504	2.267	6.000	54.000	.050*
	Roy's largest root	.355	3.429	3.000	29.000	.030*
Help received from coworkers to move equipment	Pillai's trace	.593	2.462	9.000	90.000	.015*
	Wilks' lambda	.457	2.883	9.000	68.295	.006*
	Hotelling's trace	1.081	3.204	9.000	80.000	.002*
	Roy's largest root	.970	9.704	3.000	30.000	.000*
Lifting boxes	Pillai's trace	.337	1.961	6.000	58.000	.086
	Wilks' lambda	.677	2.012	6.000	56.000	.079
	Hotelling's trace	.457	2.057	6.000	54.000	.074
	Roy's largest root	.406	3.926	3.000	29.000	.018*
Transferring pallets from one location to another	Pillai's trace	.304	4.074	3.000	28.000	.016*
	Wilks' lambda	.696	4.074	3.000	28.000	.016*
	Hotelling's trace	.437	4.074	3.000	28.000	.016*
	Roy's largest root	.437	4.074	3.000	28.000	.016*
Lifting objects from an awkward position	Pillai's trace	.084	.424	6.000	58.000	.860
	Wilks' lambda	.917	.416	6.000	56.000	.865
	Hotelling's trace	.090	.407	6.000	54.000	.871
	Roy's largest root	.082	.796	3.000	29.000	.506
Pushing or pulling objects	Pillai's trace	.042	.406	3.000	28.000	.750
	Wilks' lambda	.958	.406	3.000	28.000	.750
	Hotelling's trace	.044	.406	3.000	28.000	.750
	Roy's largest root	.044	.406	3.000	28.000	.750
Bending to pick up an object	Pillai's trace	.083	.844	3.000	28.000	.481
	Wilks' lambda	.917	.844	3.000	28.000	.481
	Hotelling's trace	.090	.844	3.000	28.000	.481
	Roy's largest root	.090	.844	3.000	28.000	.481
Performing	Pillai's trace	.096	.995	3.000	28.000	.409

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
repetitive tasks	Wilks' lambda	.904	.995	3.000	28.000	.409
	Hotelling's trace	.107	.995	3.000	28.000	.409
	Roy's largest root	.107	.995	3.000	28.000	.409
Lifting objects over the head	Pillai's trace	.404	1.555	9.000	90.000	.141
	Wilks' lambda	.618	1.660	9.000	68.295	.116
	Hotelling's trace	.584	1.729	9.000	80.000	.096
	Roy's largest root	.519	5.186	3.000	30.000	.005*
Transferring equipment without the use of lifting equipment	Pillai's trace	.614	2.574	9.000	90.000	.011*
	Wilks' lambda	.479	2.682	9.000	68.295	.010*
	Hotelling's trace	.904	2.679	9.000	80.000	.009*
	Roy's largest root	.656	6.563	3.000	30.000	.002*
Standing for a long period of time	Pillai's trace	.167	.882	6.000	58.000	.514
	Wilks' lambda	.833	.893	6.000	56.000	.506
	Hotelling's trace	.200	.902	6.000	54.000	.500
	Roy's largest root	.200	1.934	3.000	29.000	.146
Sitting in one position for an extended period of time	Pillai's trace	.249	1.372	6.000	58.000	.241
	Wilks' lambda	.754	1.413	6.000	56.000	.226
	Hotelling's trace	.322	1.449	6.000	54.000	.213
	Roy's largest root	.310	2.994	3.000	29.000	.047*
Ethnicity	Pillai's trace	.295	.817	12.000	90.000	.632
	Wilks' lambda	.726	.796	12.000	74.373	.653
	Hotelling's trace	.348	.772	12.000	80.000	.677
	Roy's largest root	.233	1.746	4.000	30.000	.166

*$p < .05$

Table 38

Tests of Between-Subjects Effects for Left Forearm Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	3.946	40	.099	1.914	.034
	Intensity	2.230	40	.056	2.603	.004
	Interference	6.053	40	.151	4.343	.000
Intercept	Frequency	.055	1	.055	1.058	.312
	Intensity	.033	1	.033	1.553	.222
	Interference	.006	1	.006	.171	.682

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Gender	Frequency	.131	2	.066	1.271	.295
	Intensity	.091	2	.045	2.122	.137
	Interference	.118	2	.059	1.693	.201
Job category	Frequency	.114	3	.038	.737	.538
	Intensity	.256	3	.085	3.986	.017*
	Interference	.179	3	.060	1.717	.185
Shift	Frequency	.084	4	.021	.406	.803
	Intensity	.060	4	.015	.695	.602
	Interference	.144	4	.036	1.034	.406
Use of pallets to move equipment	Frequency	.127	2	.064	1.236	.305
	Intensity	.055	2	.027	1.275	.294
	Interference	.230	2	.115	3.304	.050*
Help received from coworkers to move equipment	Frequency	.121	3	.040	.782	.514
	Intensity	.075	3	.025	1.172	.337
	Interference	.915	3	.305	8.759	.000*
Lifting boxes	Frequency	.182	2	.091	1.765	.189
	Intensity	.057	2	.029	1.335	.278
	Interference	.415	2	.207	5.950	.007*
Transferring pallets from one location to another	Frequency	.278	1	.278	5.391	.027*
	Intensity	.200	1	.200	9.323	.005*
	Interference	.313	1	.313	8.997	.005*
Lifting objects from an awkward position	Frequency	.030	2	.015	.287	.753
	Intensity	.004	2	.002	.095	.910
	Interference	.073	2	.037	1.048	.363
Pushing or pulling objects	Frequency	.005	1	.005	.089	.767
	Intensity	.026	1	.026	1.233	.276
	Interference	.021	1	.021	.593	.447
Bending to pick up an object	Frequency	6.281E-8	1	6.281E-8	.000	.999
	Intensity	.050	1	.050	2.351	.136
	Interference	.006	1	.006	.176	.678
Performing repetitive tasks	Frequency	.017	1	.017	.334	.567
	Intensity	.008	1	.008	.394	.535
	Interference	.062	1	.062	1.770	.193
Lifting objects over the head	Frequency	.136	3	.045	.877	.464
	Intensity	.127	3	.042	1.970	.140
	Interference	.527	3	.176	5.041	.006*
Transferring equipment without the use of lifting equipment	Frequency	.227	3	.076	1.466	.244
	Intensity	.258	3	.086	4.008	.016*
	Interference	.186	3	.062	1.778	.173

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Standing for a long period of time	Frequency	.091	2	.045	.881	.425
	Intensity	.005	2	.003	.126	.882
	Interference	.092	2	.046	1.315	.284
Sitting in one position for an extended period of time	Frequency	.246	2	.123	2.381	.110
	Intensity	.043	2	.022	1.013	.375
	Interference	3.014E-5	2	1.507E-5	.000	1.000
Ethnicity	Frequency	.096	4	.024	.467	.760
	Intensity	.087	4	.022	1.017	.414
	Interference	.240	4	.060	1.719	.172
Error	Frequency	1.547	30	.052		
	Intensity	.643	30	.021		
	Interference	1.045	30	.035		
Total	Frequency	6.000	71			
	Intensity	3.000	71			
	Interference	8.000	71			
Corrected total	Frequency	5.493	70			
	Intensity	2.873	70			
	Interference	7.099	70			

*$p < .05$

Tables 39 and 40 present the multivariate effects and univariate effects for right wrist discomfort. There was a significant difference in right wrist discomfort across job category, help received from coworkers, lifting boxes, transferring pallets, lifting objects over one's head, and sitting in one position for a protracted period of time. Specifically, the warehouse workers had greater frequency and work interference because of right wrist discomfort. Those respondents who lifted boxes less frequently had more intense right wrist discomfort and experienced greater interference from work because of right wrist discomfort. In a similar vein, those respondents who lifted objects over their head more frequently and those who sat in the same position for long periods more frequently had fewer incidences of right wrist discomfort and less interference in the work because

of right wrist discomfort. Furthermore, the participants who received more help from coworkers had more intense right wrist discomfort.

Table 39

Multivariate Tests for Right Wrist Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.420	6.761	3.000	28.000	.001
	Wilks' lambda	.580	6.761	3.000	28.000	.001
	Hotelling's trace	.724	6.761	3.000	28.000	.001
	Roy's largest root	.724	6.761	3.000	28.000	.001
Gender	Pillai's trace	.252	1.391	6.000	58.000	.234
	Wilks' lambda	.756	1.399	6.000	56.000	.231
	Hotelling's trace	.312	1.403	6.000	54.000	.230
	Roy's largest root	.274	2.644	3.000	29.000	.068
Job category	Pillai's trace	.477	1.892	9.000	90.000	.063
	Wilks' lambda	.555	2.074	9.000	68.295	.044*
	Hotelling's trace	.742	2.197	9.000	80.000	.031*
	Roy's largest root	.653	6.525	3.000	30.000	.002*
Shift	Pillai's trace	.403	1.164	12.000	90.000	.321
	Wilks' lambda	.643	1.124	12.000	74.373	.354
	Hotelling's trace	.485	1.077	12.000	80.000	.390
	Roy's largest root	.284	2.134	4.000	30.000	.101
Use of pallets to move equipment	Pillai's trace	.245	1.352	6.000	58.000	.249
	Wilks' lambda	.759	1.379	6.000	56.000	.239
	Hotelling's trace	.311	1.401	6.000	54.000	.231
	Roy's largest root	.291	2.811	3.000	29.000	.057
Help received from coworkers to move equipment	Pillai's trace	.547	2.230	9.000	90.000	.027*
	Wilks' lambda	.521	2.328	9.000	68.295	.024*
	Hotelling's trace	.791	2.344	9.000	80.000	.021*
	Roy's largest root	.598	5.983	3.000	30.000	.003*
Lifting boxes	Pillai's trace	.830	6.855	6.000	58.000	.000*
	Wilks' lambda	.341	6.643	6.000	56.000	.000*
	Hotelling's trace	1.429	6.430	6.000	54.000	.000*
	Roy's largest root	.809	7.824	3.000	29.000	.001*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Transferring pallets from one location to another	Pillai's trace	.376	5.622	3.000	28.000	.004*
	Wilks' lambda	.624	5.622	3.000	28.000	.004*
	Hotelling's trace	.602	5.622	3.000	28.000	.004*
	Roy's largest root	.602	5.622	3.000	28.000	.004*
Lifting objects from an awkward position	Pillai's trace	.236	1.291	6.000	58.000	.276
	Wilks' lambda	.770	1.301	6.000	56.000	.272
	Hotelling's trace	.290	1.307	6.000	54.000	.270
	Roy's largest root	.260	2.518	3.000	29.000	.078
Pushing or pulling objects	Pillai's trace	.037	.355	3.000	28.000	.786
	Wilks' lambda	.963	.355	3.000	28.000	.786
	Hotelling's trace	.038	.355	3.000	28.000	.786
	Roy's largest root	.038	.355	3.000	28.000	.786
Bending to pick up an object	Pillai's trace	.046	.447	3.000	28.000	.721
	Wilks' lambda	.954	.447	3.000	28.000	.721
	Hotelling's trace	.048	.447	3.000	28.000	.721
	Roy's largest root	.048	.447	3.000	28.000	.721
Performing repetitive tasks	Pillai's trace	.077	.777	3.000	28.000	.517
	Wilks' lambda	.923	.777	3.000	28.000	.517
	Hotelling's trace	.083	.777	3.000	28.000	.517
	Roy's largest root	.083	.777	3.000	28.000	.517
Lifting objects over the head	Pillai's trace	.515	2.074	9.000	90.000	.040*
	Wilks' lambda	.544	2.157	9.000	68.295	.036*
	Hotelling's trace	.730	2.162	9.000	80.000	.033*
	Roy's largest root	.521	5.205	3.000	30.000	.005*
Transferring equipment without the use of lifting equipment	Pillai's trace	.476	1.884	9.000	90.000	.064
	Wilks' lambda	.573	1.954	9.000	68.295	.059
	Hotelling's trace	.664	1.967	9.000	80.000	.054
	Roy's largest root	.513	5.131	3.000	30.000	.006*
Standing for a long period of time	Pillai's trace	.135	.701	6.000	58.000	.650
	Wilks' lambda	.867	.689	6.000	56.000	.659
	Hotelling's trace	.150	.677	6.000	54.000	.669
	Roy's largest root	.128	1.239	3.000	29.000	.313
Sitting in one position for an	Pillai's trace	.435	2.684	6.000	58.000	.023*
	Wilks' lambda	.611	2.608	6.000	56.000	.027*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
extended period of time	Hotelling's trace	.563	2.532	6.000	54.000	.031*
	Roy's largest root	.350	3.383	3.000	29.000	.031*
	Pillai's trace	.358	1.018	12.000	90.000	.440
	Wilks' lambda	.668	1.022	12.000	74.373	.438
Ethnicity	Hotelling's trace	.459	1.020	12.000	80.000	.439
	Roy's largest root	.355	2.662	4.000	30.000	.052

*$p < .05$

Table 40

Tests of Between-Subjects Effects for Right Wrist Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	8.668	40	.217	3.332	.000
	Intensity	9.141	40	.229	3.181	.001
	Interference	9.454	40	.236	3.971	.000
Intercept	Frequency	.033	1	.033	.515	.479
	Intensity	.055	1	.055	.770	.387
	Interference	.651	1	.651	10.944	.002
Gender	Frequency	.005	2	.002	.038	.962
	Intensity	.054	2	.027	.375	.691
	Interference	.148	2	.074	1.245	.302
Job category	Frequency	.812	3	.271	4.163	.014*
	Intensity	.185	3	.062	.857	.474
	Interference	1.058	3	.353	5.924	.003*
Shift	Frequency	.338	4	.085	1.301	.292
	Intensity	.291	4	.073	1.014	.416
	Interference	.227	4	.057	.955	.446
Use of pallets to move equipment	Frequency	.047	2	.023	.360	.701
	Intensity	.240	2	.120	1.673	.205
	Interference	.073	2	.036	.610	.550
Help received from coworkers to move equipment	Frequency	.376	3	.125	1.925	.147
	Intensity	.969	3	.323	4.498	.010*
	Interference	.256	3	.085	1.434	.252
Lifting boxes	Frequency	.154	2	.077	1.180	.321
	Intensity	1.223	2	.611	8.510	.001*
	Interference	.797	2	.398	6.693	.004*
Transferring	Frequency	.069	1	.069	1.063	.311
	Intensity	.168	1	.168	2.343	.136

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
pallets from one location to another	Interference	.088	1	.088	1.476	.234
Lifting objects from an awkward position	Frequency	.008	2	.004	.059	.943
	Intensity	.237	2	.118	1.646	.210
	Interference	.095	2	.048	.799	.459
Pushing or pulling objects	Frequency	.001	1	.001	.018	.893
	Intensity	.039	1	.039	.536	.470
	Interference	.001	1	.001	.016	.901
Bending to pick up an object	Frequency	.000	1	.000	.004	.947
	Intensity	.040	1	.040	.556	.462
	Interference	.007	1	.007	.116	.736
Performing repetitive tasks	Frequency	.011	1	.011	.170	.683
	Intensity	.093	1	.093	1.292	.265
	Interference	.002	1	.002	.033	.856
Lifting objects over the head	Frequency	.472	3	.157	2.420	.086
	Intensity	.255	3	.085	1.185	.332
	Interference	.755	3	.252	4.226	.013*
Transferring equipment without the use of lifting equipment	Frequency	.455	3	.152	2.331	.094
	Intensity	.298	3	.099	1.382	.267
	Interference	.078	3	.026	.434	.730
Standing for a long period of time	Frequency	.070	2	.035	.541	.588
	Intensity	.078	2	.039	.544	.586
	Interference	.043	2	.021	.361	.700
Sitting in one position for an extended period of time	Frequency	.440	2	.220	3.382	.047*
	Intensity	.195	2	.097	1.357	.273
	Interference	.459	2	.229	3.852	.032*
Ethnicity	Frequency	.608	4	.152	2.336	.078
	Intensity	.156	4	.039	.542	.706
	Interference	.390	4	.098	1.639	.190
Error	Frequency	1.951	30	.065		
	Intensity	2.155	30	.072		
	Interference	1.786	30	.060		
Total	Frequency	13.000	71			
	Intensity	13.000	71			
	Interference	14.000	71			
Corrected total	Frequency	10.620	70			
	Intensity	11.296	70			
	Interference	11.239	70			

*$p < .05$

Tables 41 and 42 present the multivariate effects and univariate effects for left wrist discomfort. Findings for left wrist discomfort were similar to those obtained for right wrist discomfort. There was a significant difference in left wrist discomfort across job category, shift, help received from coworkers, lifting boxes, transferring pallets, lifting objects over one's head, transferring objects without equipment, sitting in one position for a protracted period of time, and ethnicity. Again, the warehouse workers had greater frequency and work interference because of left wrist discomfort. Forklift workers also had greater work interference because of left wrist discomfort. Left wrist discomfort also was more frequent and interfered with work more often among the participants working the permanent night shift. Just as observed for those with right wrist discomfort, those participants who lifted boxes less frequently had more intense left wrist discomfort and experienced greater interference from work due to left wrist discomfort. Once again, those participants who lifted objects over their head less frequently and those who sat in the same position for long periods less frequently had fewer incidences of left wrist discomfort and less interference in the work because of left wrist discomfort. Furthermore, the participants who received more help from coworkers had more frequent and more intense left wrist discomfort. The White participants had more frequent left wrist discomfort and experienced more interference with work because of left wrist discomfort.

Table 41

Multivariate Tests for Left Wrist Discomfort

	Effect	Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.502	9.395	3.000	28.000	p<.001

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Wilks' lambda	.498	9.395	3.000	28.000	p<.001
	Hotelling's trace	1.007	9.395	3.000	28.000	p<.001
	Roy's largest root	1.007	9.395	3.000	28.000	p<.001
Gender	Pillai's trace	.293	1.660	6.000	58.000	.147
	Wilks' lambda	.717	1.687	6.000	56.000	.141
	Hotelling's trace	.380	1.709	6.000	54.000	.137
	Roy's largest root	.337	3.259	3.000	29.000	.036
Job category	Pillai's trace	.744	3.300	9.000	90.000	.002*
	Wilks' lambda	.313	4.638	9.000	68.295	.000*
	Hotelling's trace	2.010	5.954	9.000	80.000	.000*
	Roy's largest root	1.914	19.145	3.000	30.000	.000*
Shift	Pillai's trace	.592	1.844	12.000	90.000	.053
	Wilks' lambda	.491	1.913	12.000	74.373	.046*
	Hotelling's trace	.876	1.946	12.000	80.000	.041*
	Roy's largest root	.658	4.935	4.000	30.000	.004*
Use of pallets to move equipment	Pillai's trace	.257	1.428	6.000	58.000	.220
	Wilks' lambda	.752	1.428	6.000	56.000	.220
	Hotelling's trace	.316	1.424	6.000	54.000	.223
	Roy's largest root	.268	2.593	3.000	29.000	.072
Help received from coworkers to move equipment	Pillai's trace	.603	2.515	9.000	90.000	.013*
	Wilks' lambda	.491	2.575	9.000	68.295	.013*
	Hotelling's trace	.851	2.522	9.000	80.000	.013*
	Roy's largest root	.540	5.405	3.000	30.000	.004*
Lifting boxes	Pillai's trace	.908	8.032	6.000	58.000	.000*
	Wilks' lambda	.293	7.922	6.000	56.000	.000*
	Hotelling's trace	1.734	7.802	6.000	54.000	.000*
	Roy's largest root	1.126	10.887	3.000	29.000	.000*
Transferring pallets from one location to another	Pillai's trace	.422	6.808	3.000	28.000	.001*
	Wilks' lambda	.578	6.808	3.000	28.000	.001*
	Hotelling's trace	.729	6.808	3.000	28.000	.001*
	Roy's largest root	.729	6.808	3.000	28.000	.001*
Lifting objects from an awkward	Pillai's trace	.242	1.332	6.000	58.000	.258
	Wilks' lambda	.759	1.377	6.000	56.000	.240
	Hotelling's trace	.315	1.417	6.000	54.000	.225

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
position	Roy's largest root	.308	2.979	3.000	29.000	.048*
Pushing or pulling objects	Pillai's trace	.049	.477	3.000	28.000	.701
	Wilks' lambda	.951	.477	3.000	28.000	.701
	Hotelling's trace	.051	.477	3.000	28.000	.701
	Roy's largest root	.051	.477	3.000	28.000	.701
Bending to pick up an object	Pillai's trace	.054	.533	3.000	28.000	.664
	Wilks' lambda	.946	.533	3.000	28.000	.664
	Hotelling's trace	.057	.533	3.000	28.000	.664
	Roy's largest root	.057	.533	3.000	28.000	.664
Performing repetitive tasks	Pillai's trace	.063	.632	3.000	28.000	.600
	Wilks' lambda	.937	.632	3.000	28.000	.600
	Hotelling's trace	.068	.632	3.000	28.000	.600
	Roy's largest root	.068	.632	3.000	28.000	.600
Lifting objects over the head	Pillai's trace	.721	3.163	9.000	90.000	.002*
	Wilks' lambda	.393	3.548	9.000	68.295	.001*
	Hotelling's trace	1.253	3.713	9.000	80.000	.001*
	Roy's largest root	.947	9.470	3.000	30.000	.000*
Transferring equipment without the use of lifting equipment	Pillai's trace	.615	2.580	9.000	90.000	.011*
	Wilks' lambda	.457	2.877	9.000	68.295	.006*
	Hotelling's trace	1.032	3.057	9.000	80.000	.003*
	Roy's largest root	.863	8.627	3.000	30.000	.000*
Standing for a long period of time	Pillai's trace	.099	.506	6.000	58.000	.802
	Wilks' lambda	.901	.501	6.000	56.000	.805
	Hotelling's trace	.110	.495	6.000	54.000	.809
	Roy's largest root	.108	1.046	3.000	29.000	.387
Sitting in one position for an extended period of time	Pillai's trace	.409	2.482	6.000	58.000	.033*
	Wilks' lambda	.633	2.401	6.000	56.000	.039*
	Hotelling's trace	.516	2.321	6.000	54.000	.046*
	Roy's largest root	.296	2.860	3.000	29.000	.054*
Ethnicity	Pillai's trace	.537	1.635	12.000	90.000	.096*
	Wilks' lambda	.508	1.810	12.000	74.373	.062*
	Hotelling's trace	.883	1.962	12.000	80.000	.039*
	Roy's largest root	.773	5.794	4.000	30.000	.001*

*$p < .05$

Table 42

Tests of Between-Subjects Effects for Left Wrist Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	8.882	40	.222	6.111	.000
	Intensity	9.141	40	.229	3.181	.001
	Interference	9.626	40	.241	7.261	.000
Intercept	Frequency	.042	1	.042	1.153	.291
	Intensity	.055	1	.055	.770	.387
	Interference	.687	1	.687	20.729	.000
Gender	Frequency	.001	2	.001	.020	.980
	Intensity	.054	2	.027	.375	.691
	Interference	.206	2	.103	3.103	.060
Job category	Frequency	.829	3	.276	7.610	.001*
	Intensity	.185	3	.062	.857	.474
	Interference	1.079	3	.360	10.855	.000*
Shift	Frequency	.422	4	.106	2.905	.038*
	Intensity	.291	4	.073	1.014	.416
	Interference	.329	4	.082	2.482	.065
Use of pallets to move equipment	Frequency	.087	2	.044	1.200	.315
	Intensity	.240	2	.120	1.673	.205
	Interference	.042	2	.021	.627	.541
Help received from coworkers to move equipment	Frequency	.478	3	.159	4.385	.011*
	Intensity	.969	3	.323	4.498	.010*
	Interference	.262	3	.087	2.631	.068
Lifting boxes	Frequency	.191	2	.096	2.629	.089
	Intensity	1.223	2	.611	8.510	.001*
	Interference	.771	2	.385	11.629	.000*
Transferring pallets from one location to another	Frequency	.089	1	.089	2.459	.127
	Intensity	.168	1	.168	2.343	.136
	Interference	.068	1	.068	2.047	.163
Lifting objects from an awkward position	Frequency	.006	2	.003	.076	.927
	Intensity	.237	2	.118	1.646	.210
	Interference	.055	2	.028	.837	.443
Pushing or pulling objects	Frequency	.025	1	.025	.689	.413
	Intensity	.039	1	.039	.536	.470
	Interference	.050	1	.050	1.507	.229
Bending to pick up an object	Frequency	.059	1	.059	1.628	.212
	Intensity	.040	1	.040	.556	.462

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
	Interference	.020	1	.020	.617	.438
Performing repetitive tasks	Frequency	.037	1	.037	1.008	.323
	Intensity	.093	1	.093	1.292	.265
	Interference	.002	1	.002	.053	.820
Lifting objects over the head	Frequency	.484	3	.161	4.444	.011*
	Intensity	.255	3	.085	1.185	.332
	Interference	.797	3	.266	8.014	.000*
Transferring equipment without the use of lifting equipment	Frequency	.662	3	.221	6.076	.002*
	Intensity	.298	3	.099	1.382	.267
	Interference	.170	3	.057	1.707	.187
Standing for a long period of time	Frequency	.035	2	.017	.476	.626
	Intensity	.078	2	.039	.544	.586
	Interference	.105	2	.053	1.587	.221
Sitting in one position for an extended period of time	Frequency	.232	2	.116	3.191	.055
	Intensity	.195	2	.097	1.357	.273
	Interference	.177	2	.088	2.668	.086
Ethnicity	Frequency	.521	4	.130	3.583	.017*
	Intensity	.156	4	.039	.542	.706
	Interference	.381	4	.095	2.876	.040*
Error	Frequency	1.090	30	.036		
	Intensity	2.155	30	.072		
	Interference	.994	30	.033		
Total	Frequency	12.000	71			
	Intensity	13.000	71			
	Interference	13.000	71			
Corrected Total	Frequency	9.972	70			
	Intensity	11.296	70			
	Interference	10.620	70			

*$p < .05$

Tables 43 and 44 present the multivariate effects and univariate effects for hip/buttock discomfort. The findings for hip/buttock discomfort were significant across shift, use of pallets to move objects, lifting boxes, and lifting objects over one's head. Nearly significant differences also were observed across gender. Specifically, the female participants experienced more interference with work because of hip/buttock discomfort than the male participants did. The participants also who less frequently used pallets to

move equipment had more intense hip/buttock discomfort. However, there was greater intensity of discomfort among the participants working the rotating day/night shift, whereas those participants on the permanent evening and permanent night shifts had the great interference with work because of hip/buttock discomfort. Furthermore, intensity of discomfort and work interference due to discomfort was the highest among the participants who frequently lifted boxes. Hip/Buttock discomfort was higher among those participants who only sometimes had to lift objects over their heads.

Table 43

Multivariate Tests for Hip/Buttock Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.276	3.566	3.000	28.000	.027
	Wilks' lambda	.724	3.566	3.000	28.000	.027
	Hotelling's trace	.382	3.566	3.000	28.000	.027
	Roy's largest root	.382	3.566	3.000	28.000	.027
Gender	Pillai's trace	.367	2.175	6.000	58.000	.058
	Wilks' lambda	.644	2.297	6.000	56.000	.047*
	Hotelling's trace	.535	2.408	6.000	54.000	.039*
	Roy's largest root	.500	4.830	3.000	29.000	.008*
Job category	Pillai's trace	.206	.737	9.000	90.000	.674
	Wilks' lambda	.806	.704	9.000	68.295	.703
	Hotelling's trace	.227	.672	9.000	80.000	.732
	Roy's largest root	.139	1.392	3.000	30.000	.264
Shift	Pillai's trace	.628	1.985	12.000	90.000	.035*
	Wilks' lambda	.460	2.117	12.000	74.373	.026*
	Hotelling's trace	.991	2.203	12.000	80.000	.019*
	Roy's largest root	.768	5.763	4.000	30.000	.001*
Use of pallets to move equipment	Pillai's trace	.440	2.723	6.000	58.000	.021*
	Wilks' lambda	.566	3.073	6.000	56.000	.011*
	Hotelling's trace	.757	3.407	6.000	54.000	.006*
	Roy's largest root	.744	7.192	3.000	29.000	.001*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Help received from coworkers to move equipment	Pillai's trace	.344	1.295	9.000	90.000	.251
	Wilks' lambda	.671	1.353	9.000	68.295	.227
	Hotelling's trace	.469	1.388	9.000	80.000	.207
	Roy's largest root	.416	4.156	3.000	30.000	.014*
Lifting boxes	Pillai's trace	.496	3.190	6.000	58.000	.009*
	Wilks' lambda	.554	3.205	6.000	56.000	.009*
	Hotelling's trace	.714	3.211	6.000	54.000	.009*
	Roy's largest root	.547	5.291	3.000	29.000	.005*
Transferring pallets from one location to another	Pillai's trace	.040	.391	3.000	28.000	.760
	Wilks' lambda	.960	.391	3.000	28.000	.760
	Hotelling's trace	.042	.391	3.000	28.000	.760
	Roy's largest root	.042	.391	3.000	28.000	.760
Lifting objects from an awkward position	Pillai's trace	.342	1.993	6.000	58.000	.081
	Wilks' lambda	.665	2.110	6.000	56.000	.066
	Hotelling's trace	.493	2.217	6.000	54.000	.055
	Roy's largest root	.470	4.544	3.000	29.000	.010*
Pushing or pulling objects	Pillai's trace	.205	2.408	3.000	28.000	.088
	Wilks' lambda	.795	2.408	3.000	28.000	.088
	Hotelling's trace	.258	2.408	3.000	28.000	.088
	Roy's largest root	.258	2.408	3.000	28.000	.088
Bending to pick up an object	Pillai's trace	.009	.089	3.000	28.000	.966
	Wilks' lambda	.991	.089	3.000	28.000	.966
	Hotelling's trace	.010	.089	3.000	28.000	.966
	Roy's largest root	.010	.089	3.000	28.000	.966
Performing repetitive tasks	Pillai's trace	.176	1.999	3.000	28.000	.137
	Wilks' lambda	.824	1.999	3.000	28.000	.137
	Hotelling's trace	.214	1.999	3.000	28.000	.137
	Roy's largest root	.214	1.999	3.000	28.000	.137
Lifting objects over the head	Pillai's trace	.577	2.380	9.000	90.000	.018*
	Wilks' lambda	.488	2.606	9.000	68.295	.012*
	Hotelling's trace	.919	2.724	9.000	80.000	.008*
	Roy's largest root	.742	7.419	3.000	30.000	.001*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Transferring equipment without the use of lifting equipment	Pillai's trace	.242	.879	9.000	90.000	.547
	Wilks' lambda	.772	.850	9.000	68.295	.573
	Hotelling's trace	.276	.819	9.000	80.000	.600
	Roy's largest root	.191	1.906	3.000	30.000	.150
Standing for a long period of time	Pillai's trace	.215	1.162	6.000	58.000	.339
	Wilks' lambda	.793	1.149	6.000	56.000	.347
	Hotelling's trace	.252	1.133	6.000	54.000	.356
	Roy's largest root	.206	1.987	3.000	29.000	.138
Sitting in one position for an extended period of time	Pillai's trace	.083	.420	6.000	58.000	.863
	Wilks' lambda	.917	.414	6.000	56.000	.867
	Hotelling's trace	.090	.407	6.000	54.000	.871
	Roy's largest root	.088	.847	3.000	29.000	.480
Ethnicity	Pillai's trace	.359	1.018	12.000	90.000	.439
	Wilks' lambda	.673	1.001	12.000	74.373	.457
	Hotelling's trace	.439	.976	12.000	80.000	.478
	Roy's largest root	.269	2.016	4.000	30.000	.117

*$p < .05$

Table 44

Tests of Between-Subjects Effects for Hip/Buttock Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	5.405	40	.135	1.097	.400
	Intensity	10.782	40	.270	1.593	.094
	Interference	7.858	40	.196	2.156	.016
Intercept	Frequency	.160	1	.160	1.299	.263
	Intensity	.524	1	.524	3.096	.089
	Interference	.025	1	.025	.278	.602
Gender	Frequency	.268	2	.134	1.087	.350
	Intensity	.545	2	.272	1.610	.217
	Interference	1.172	2	.586	6.433	.005*
Job category	Frequency	.130	3	.043	.353	.787
	Intensity	.295	3	.098	.580	.632
	Interference	.133	3	.044	.487	.694
Shift	Frequency	.608	4	.152	1.234	.318
	Intensity	2.007	4	.502	2.965	.035*
	Interference	1.076	4	.269	2.952	.036*

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Use of pallets to move equipment	Frequency	.523	2	.262	2.125	.137
	Intensity	1.849	2	.924	5.462	.009*
	Interference	.078	2	.039	.426	.657
Help received from coworkers to move equipment	Frequency	.254	3	.085	.688	.566
	Intensity	1.059	3	.353	2.085	.123
	Interference	.193	3	.064	.707	.555
Lifting boxes	Frequency	.298	2	.149	1.210	.312
	Intensity	1.089	2	.544	3.217	.054*
	Interference	.460	2	.230	2.521	.097
Transferring pallets from one location to another	Frequency	.011	1	.011	.086	.772
	Intensity	.005	1	.005	.029	.867
	Interference	.001	1	.001	.007	.936
Lifting objects from an awkward position	Frequency	.817	2	.408	3.316	.050*
	Intensity	2.029	2	1.014	5.994	.006*
	Interference	.483	2	.242	2.651	.087
Pushing or pulling objects	Frequency	.313	1	.313	2.539	.122
	Intensity	.933	1	.933	5.515	.026*
	Interference	.459	1	.459	5.042	.032*
Bending to pick up an object	Frequency	.000	1	.000	.003	.957
	Intensity	.012	1	.012	.068	.796
	Interference	.009	1	.009	.094	.761
Performing repetitive tasks	Frequency	.086	1	.086	.701	.409
	Intensity	.494	1	.494	2.918	.098
	Interference	.049	1	.049	.534	.471
Lifting objects over the head	Frequency	.665	3	.222	1.800	.169
	Intensity	.750	3	.250	1.478	.240
	Interference	1.309	3	.436	4.789	.008*
Transferring equipment without the use of lifting equipment	Frequency	.230	3	.077	.623	.605
	Intensity	.376	3	.125	.740	.537
	Interference	.154	3	.051	.563	.644
Standing for a long period of time	Frequency	.220	2	.110	.893	.420
	Intensity	.709	2	.355	2.095	.141
	Interference	.386	2	.193	2.115	.138
Sitting in one position for an extended period of time	Frequency	.050	2	.025	.205	.816
	Intensity	.181	2	.091	.535	.591
	Interference	.195	2	.097	1.069	.356
Ethnicity	Frequency	.168	4	.042	.342	.848
	Intensity	.742	4	.185	1.095	.377
	Interference	.478	4	.119	1.310	.289

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Error	Frequency	3.694	30	.123		
	Intensity	5.077	30	.169		
	Interference	2.734	30	.091		
Total	Frequency	10.000	71			
	Intensity	17.000	71			
	Interference	12.000	71			
Corrected total	Frequency	9.099	70			
	Intensity	15.859	70			
	Interference	10.592	70			

*$p < .05$

Tables 45 and 46 present the multivariate effects and univariate effects for right thigh discomfort. There were no significant group differences observed, but the effect for help received from coworkers was nearly significant for right thigh discomfort. The participants who received more help from their coworkers experienced slightly more intense discomfort in the right thigh, but this effect did not redound to interference with work.

Table 45

Multivariate Tests for Right Thigh Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.230	2.789	3.000	28.000	.059
	Wilks' lambda	.770	2.789	3.000	28.000	.059
	Hotelling's trace	.299	2.789	3.000	28.000	.059
	Roy's largest root	.299	2.789	3.000	28.000	.059
Gender	Pillai's trace	.184	.981	6.000	58.000	.446
	Wilks' lambda	.817	.992	6.000	56.000	.440
	Hotelling's trace	.222	.999	6.000	54.000	.435
	Roy's largest root	.214	2.070	3.000	29.000	.126
Job category	Pillai's trace	.295	1.090	9.000	90.000	.378
	Wilks' lambda	.723	1.081	9.000	68.295	.388
	Hotelling's trace	.358	1.062	9.000	80.000	.400

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Roy's largest root	.275	2.747	3.000	30.000	.060
Shift	Pillai's trace	.509	1.533	12.000	90.000	.127
	Wilks' lambda	.549	1.579	12.000	74.373	.116
	Hotelling's trace	.721	1.602	12.000	80.000	.108
	Roy's largest root	.554	4.154	4.000	30.000	.009*
Use of pallets to move equipment	Pillai's trace	.117	.600	6.000	58.000	.729
	Wilks' lambda	.883	.598	6.000	56.000	.731
	Hotelling's trace	.132	.594	6.000	54.000	.734
	Roy's largest root	.131	1.266	3.000	29.000	.304
Help received from coworkers to move equipment	Pillai's trace	.484	1.924	9.000	90.000	.058
	Wilks' lambda	.566	1.998	9.000	68.295	.053
	Hotelling's trace	.678	2.010	9.000	80.000	.049*
	Roy's largest root	.514	5.143	3.000	30.000	.005*
Lifting boxes	Pillai's trace	.263	1.465	6.000	58.000	.206
	Wilks' lambda	.740	1.514	6.000	56.000	.191
	Hotelling's trace	.346	1.557	6.000	54.000	.178
	Roy's largest root	.332	3.205	3.000	29.000	.038*
Transferring pallets from one location to another	Pillai's trace	.054	.535	3.000	28.000	.662
	Wilks' lambda	.946	.535	3.000	28.000	.662
	Hotelling's trace	.057	.535	3.000	28.000	.662
	Roy's largest root	.057	.535	3.000	28.000	.662
Lifting objects from an awkward position	Pillai's trace	.161	.844	6.000	58.000	.542
	Wilks' lambda	.846	.815	6.000	56.000	.563
	Hotelling's trace	.175	.787	6.000	54.000	.584
	Roy's largest root	.098	.951	3.000	29.000	.429
Pushing or pulling objects	Pillai's trace	.107	1.113	3.000	28.000	.361
	Wilks' lambda	.893	1.113	3.000	28.000	.361
	Hotelling's trace	.119	1.113	3.000	28.000	.361
	Roy's largest root	.119	1.113	3.000	28.000	.361
Bending to pick up an object	Pillai's trace	.045	.443	3.000	28.000	.724
	Wilks' lambda	.955	.443	3.000	28.000	.724
	Hotelling's trace	.047	.443	3.000	28.000	.724
	Roy's largest root	.047	.443	3.000	28.000	.724
Performing	Pillai's trace	.048	.472	3.000	28.000	.705

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
repetitive tasks	Wilks' lambda	.952	.472	3.000	28.000	.705
	Hotelling's trace	.051	.472	3.000	28.000	.705
	Roy's largest root	.051	.472	3.000	28.000	.705
Lifting objects over the head	Pillai's trace	.270	.988	9.000	90.000	.456
	Wilks' lambda	.742	.988	9.000	68.295	.458
	Hotelling's trace	.331	.980	9.000	80.000	.463
	Roy's largest root	.275	2.753	3.000	30.000	.060
Transferring equipment without the use of lifting equipment	Pillai's trace	.357	1.350	9.000	90.000	.223
	Wilks' lambda	.651	1.465	9.000	68.295	.179
	Hotelling's trace	.525	1.555	9.000	80.000	.143
	Roy's largest root	.502	5.019	3.000	30.000	.006*
Standing for a long period of time	Pillai's trace	.095	.483	6.000	58.000	.818
	Wilks' lambda	.905	.476	6.000	56.000	.824
	Hotelling's trace	.104	.468	6.000	54.000	.829
	Roy's largest root	.098	.949	3.000	29.000	.430
Sitting in one position for an extended period of time	Pillai's trace	.116	.594	6.000	58.000	.734
	Wilks' lambda	.884	.591	6.000	56.000	.736
	Hotelling's trace	.130	.587	6.000	54.000	.739
	Roy's largest root	.128	1.241	3.000	29.000	.313
Ethnicity	Pillai's trace	.478	1.420	12.000	90.000	.171
	Wilks' lambda	.569	1.473	12.000	74.373	.154
	Hotelling's trace	.678	1.507	12.000	80.000	.139
	Roy's largest root	.543	4.071	4.000	30.000	.009*

* $p < .05$

Table 46

Tests of Between-Subjects Effects for Right Thigh Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	4.714	40	.118	1.124	.373
	Intensity	2.455	40	.061	1.395	.173
	Interference	4.769	40	.119	1.158	.342
Intercept	Frequency	.487	1	.487	4.644	.039
	Intensity	.108	1	.108	2.464	.127
	Interference	.000	1	.000	.005	.947
Gender	Frequency	.488	2	.244	2.330	.115
	Intensity	.000	2	.000	.003	.997
	Interference	.083	2	.042	.404	.671
Job category	Frequency	.200	3	.067	.635	.598
	Intensity	.040	3	.013	.306	.821
	Interference	.501	3	.167	1.623	.205
Shift	Frequency	.557	4	.139	1.328	.282
	Intensity	.128	4	.032	.727	.581
	Interference	.355	4	.089	.862	.498
Use of pallets to move equipment	Frequency	.217	2	.109	1.037	.367
	Intensity	.130	2	.065	1.480	.244
	Interference	.027	2	.013	.130	.879
Help received from coworkers to move equipment	Frequency	.383	3	.128	1.217	.321
	Intensity	.519	3	.173	3.935	.018*
	Interference	.064	3	.021	.206	.891
Lifting boxes	Frequency	.234	2	.117	1.115	.341
	Intensity	.057	2	.028	.646	.531
	Interference	.131	2	.066	.636	.536
Transferring pallets from one location to another	Frequency	.087	1	.087	.831	.369
	Intensity	.026	1	.026	.596	.446
	Interference	.169	1	.169	1.644	.210
Lifting objects from an awkward position	Frequency	.256	2	.128	1.222	.309
	Intensity	.049	2	.024	.557	.579
	Interference	.079	2	.040	.385	.684
Pushing or pulling objects	Frequency	.091	1	.091	.868	.359
	Intensity	.049	1	.049	1.124	.297
	Interference	.334	1	.334	3.241	.082
Bending to pick up an object	Frequency	.016	1	.016	.155	.697
	Intensity	.015	1	.015	.350	.559
	Interference	.011	1	.011	.111	.741

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Performing repetitive tasks	Frequency	.046	1	.046	.438	.513
	Intensity	.064	1	.064	1.452	.238
	Interference	.052	1	.052	.503	.484
Lifting objects over the head	Frequency	.551	3	.184	1.751	.178
	Intensity	.042	3	.014	.322	.810
	Interference	.091	3	.030	.295	.829
Transferring equipment without the use of lifting equipment	Frequency	.062	3	.021	.198	.897
	Intensity	.108	3	.036	.821	.493
	Interference	.585	3	.195	1.893	.152
Standing for a long period of time	Frequency	.120	2	.060	.574	.570
	Intensity	.014	2	.007	.163	.850
	Interference	.143	2	.071	.694	.508
Sitting in one position for an extended period of time	Frequency	.076	2	.038	.361	.700
	Intensity	.027	2	.013	.301	.742
	Interference	.057	2	.028	.275	.762
Ethnicity	Frequency	.485	4	.121	1.158	.349
	Intensity	.153	4	.038	.868	.495
	Interference	.348	4	.087	.845	.508
Error	Frequency	3.145	30	.105		
	Intensity	1.320	30	.044		
	Interference	3.090	30	.103		
Total	Frequency	9.000	71			
	Intensity	4.000	71			
	Interference	9.000	71			
Corrected Total	Frequency	7.859	70			
	Intensity	3.775	70			
	Interference	7.859	70			

*$p < .05$

Tables 47 and 48 present the multivariate effects and univariate effects for left thigh discomfort. Results for left thigh discomfort resembled those obtained for right thigh discomfort in that significant group differences observed only across help received by coworkers. Once again, those participants who received more help from coworkers experienced more intense left thigh discomfort, but there was still no effect on interference with work.

Table 47

Multivariate Tests for Left Thigh Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.269	3.432	3.000	28.000	.030
	Wilks' lambda	.731	3.432	3.000	28.000	.030
	Hotelling's trace	.368	3.432	3.000	28.000	.030
	Roy's largest root	.368	3.432	3.000	28.000	.030
Gender	Pillai's trace	.218	1.182	6.000	58.000	.328
	Wilks' lambda	.786	1.192	6.000	56.000	.324
	Hotelling's trace	.266	1.199	6.000	54.000	.321
	Roy's largest root	.244	2.361	3.000	29.000	.092
Job category	Pillai's trace	.326	1.220	9.000	90.000	.293
	Wilks' lambda	.688	1.259	9.000	68.295	.275
	Hotelling's trace	.432	1.280	9.000	80.000	.261
	Roy's largest root	.377	3.770	3.000	30.000	.021*
Shift	Pillai's trace	.551	1.686	12.000	90.000	.083
	Wilks' lambda	.506	1.822	12.000	74.373	.060
	Hotelling's trace	.868	1.929	12.000	80.000	.043*
	Roy's largest root	.723	5.426	4.000	30.000	.002*
Use of pallets to move equipment	Pillai's trace	.202	1.087	6.000	58.000	.381
	Wilks' lambda	.799	1.107	6.000	56.000	.370
	Hotelling's trace	.250	1.124	6.000	54.000	.361
	Roy's largest root	.243	2.346	3.000	29.000	.093
Help received from coworkers to move equipment	Pillai's trace	.511	2.054	9.000	90.000	.042*
	Wilks' lambda	.529	2.266	9.000	68.295	.028*
	Hotelling's trace	.813	2.410	9.000	80.000	.018*
	Roy's largest root	.711	7.112	3.000	30.000	.001*
Lifting boxes	Pillai's trace	.362	2.136	6.000	58.000	.063
	Wilks' lambda	.663	2.127	6.000	56.000	.064
	Hotelling's trace	.470	2.113	6.000	54.000	.067
	Roy's largest root	.365	3.532	3.000	29.000	.027*
Transferring pallets from one location to	Pillai's trace	.035	.342	3.000	28.000	.795
	Wilks' lambda	.965	.342	3.000	28.000	.795
	Hotelling's trace	.037	.342	3.000	28.000	.795

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
another	Roy's largest root	.037	.342	3.000	28.000	.795
Lifting objects from an awkward position	Pillai's trace	.166	.874	6.000	58.000	.519
	Wilks' lambda	.837	.869	6.000	56.000	.524
	Hotelling's trace	.191	.861	6.000	54.000	.529
	Roy's largest root	.171	1.656	3.000	29.000	.198
Pushing or pulling objects	Pillai's trace	.084	.860	3.000	28.000	.473
	Wilks' lambda	.916	.860	3.000	28.000	.473
	Hotelling's trace	.092	.860	3.000	28.000	.473
	Roy's largest root	.092	.860	3.000	28.000	.473
Bending to pick up an object	Pillai's trace	.011	.102	3.000	28.000	.958
	Wilks' lambda	.989	.102	3.000	28.000	.958
	Hotelling's trace	.011	.102	3.000	28.000	.958
	Roy's largest root	.011	.102	3.000	28.000	.958
Performing repetitive tasks	Pillai's trace	.024	.226	3.000	28.000	.877
	Wilks' lambda	.976	.226	3.000	28.000	.877
	Hotelling's trace	.024	.226	3.000	28.000	.877
	Roy's largest root	.024	.226	3.000	28.000	.877
Lifting objects over the head	Pillai's trace	.373	1.418	9.000	90.000	.192
	Wilks' lambda	.658	1.424	9.000	68.295	.195
	Hotelling's trace	.474	1.404	9.000	80.000	.200
	Roy's largest root	.355	3.551	3.000	30.000	.026*
Transferring equipment without the use of lifting equipment	Pillai's trace	.409	1.579	9.000	90.000	.133
	Wilks' lambda	.615	1.677	9.000	68.295	.112
	Hotelling's trace	.586	1.737	9.000	80.000	.094
	Roy's largest root	.509	5.094	3.000	30.000	.006*
Standing for a long period of time	Pillai's trace	.091	.460	6.000	58.000	.835
	Wilks' lambda	.910	.450	6.000	56.000	.842
	Hotelling's trace	.098	.440	6.000	54.000	.849
	Roy's largest root	.086	.830	3.000	29.000	.488
Sitting in one position for an extended period of time	Pillai's trace	.107	.546	6.000	58.000	.771
	Wilks' lambda	.894	.536	6.000	56.000	.778
	Hotelling's trace	.117	.526	6.000	54.000	.786
	Roy's largest root	.104	1.007	3.000	29.000	.404
Ethnicity	Pillai's trace	.477	1.417	12.000	90.000	.173

Effect	Value	*F*	Hypothesis *df*	Error *df*	Sig.
Wilks' lambda	.546	1.592	12.000	74.373	.112
Hotelling's trace	.789	1.754	12.000	80.000	.071
Roy's largest root	.734	5.501	4.000	30.000	.002*

* p < .05

Table 48

Tests of Between-Subjects Effects for Left Thigh Discomfort

Source	DV	Type III sum of squares	*Df*	*MS*	*F*	Sig.
Corrected model	Frequency	4.714	40	.118	1.124	.373
	Intensity	2.001	40	.050	1.720	.063
	Interference	4.789	40	.120	.944	.572
Intercept	Frequency	.487	1	.487	4.644	.039
	Intensity	.050	1	.050	1.719	.200
	Interference	.010	1	.010	.077	.784
Gender	Frequency	.488	2	.244	2.330	.115
	Intensity	.016	2	.008	.272	.764
	Interference	.100	2	.050	.394	.677
Job category	Frequency	.200	3	.067	.635	.598
	Intensity	.004	3	.001	.048	.986
	Interference	.436	3	.145	1.148	.346
Shift	Frequency	.557	4	.139	1.328	.282
	Intensity	.070	4	.018	.602	.664
	Interference	.236	4	.059	.465	.761
Use of pallets to move equipment	Frequency	.217	2	.109	1.037	.367
	Intensity	.176	2	.088	3.023	.064
	Interference	.081	2	.041	.320	.728
Help received from coworkers to move equipment	Frequency	.383	3	.128	1.217	.321
	Intensity	.485	3	.162	5.554	.004*
	Interference	.103	3	.034	.271	.846
Lifting boxes	Frequency	.234	2	.117	1.115	.341
	Intensity	.096	2	.048	1.655	.208
	Interference	.047	2	.023	.184	.833
Transferring pallets from one location to another	Frequency	.087	1	.087	.831	.369
	Intensity	.001	1	.001	.024	.878
	Interference	.133	1	.133	1.045	.315
Lifting objects from an awkward position	Frequency	.256	2	.128	1.222	.309
	Intensity	.028	2	.014	.484	.621
	Interference	.114	2	.057	.451	.641

Source	DV	Type III sum of squares	*Df*	*MS*	*F*	Sig.
Pushing or pulling objects	Frequency	.091	1	.091	.868	.359
	Intensity	.010	1	.010	.358	.554
	Interference	.218	1	.218	1.723	.199
Bending to pick up an object	Frequency	.016	1	.016	.155	.697
	Intensity	.008	1	.008	.259	.615
	Interference	.011	1	.011	.089	.768
Performing repetitive tasks	Frequency	.046	1	.046	.438	.513
	Intensity	.012	1	.012	.401	.531
	Interference	.066	1	.066	.519	.477
Lifting objects over the head	Frequency	.551	3	.184	1.751	.178
	Intensity	.059	3	.020	.676	.574
	Interference	.144	3	.048	.379	.769
Transferring equipment without the use of lifting equipment	Frequency	.062	3	.021	.198	.897
	Intensity	.049	3	.016	.556	.648
	Interference	.559	3	.186	1.470	.242
Standing for a long period of time	Frequency	.120	2	.060	.574	.570
	Intensity	.008	2	.004	.136	.874
	Interference	.292	2	.146	1.154	.329
Sitting in one position for an extended period of time	Frequency	.076	2	.038	.361	.700
	Intensity	.062	2	.031	1.065	.357
	Interference	.014	2	.007	.057	.945
Ethnicity	Frequency	.485	4	.121	1.158	.349
	Intensity	.030	4	.008	.258	.902
	Interference	.188	4	.047	.371	.827
Error	Frequency	3.145	30	.105		
	Intensity	.873	30	.029		
	Interference	3.803	30	.127		
Total	Frequency	9.000	71			
	Intensity	3.000	71			
	Interference	10.000	71			
Corrected Total	Frequency	7.859	70			
	Intensity	2.873	70			
	Interference	8.592	70			

*$p < .05$

Tables 49 and 50 present the multivariate effects and univariate effects for right knee discomfort. Significant differences in right knee discomfort were observed across frequency of bending to pick up objects. Nearly significant differences were observed

across use of pallets to move equipment and across ethnicity. Specifically, those participants who more frequently had to bend to pick up objects had more frequent right knee discomfort, which also interfered more with their work. Furthermore, the participants who used pallets to move equipment and objects had much lower intensities of right knee discomfort. Right knee discomfort also was remarkably higher among the Asian participants.

Table 49

Multivariate Tests for Right Knee Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.160	1.772	3.000	28.000	.175
	Wilks' lambda	.840	1.772	3.000	28.000	.175
	Hotelling's trace	.190	1.772	3.000	28.000	.175
	Roy's largest root	.190	1.772	3.000	28.000	.175
Gender	Pillai's trace	.174	.921	6.000	58.000	.487
	Wilks' lambda	.833	.890	6.000	56.000	.509
	Hotelling's trace	.191	.859	6.000	54.000	.531
	Roy's largest root	.107	1.035	3.000	29.000	.392
Job category	Pillai's trace	.301	1.116	9.000	90.000	.360
	Wilks' lambda	.724	1.079	9.000	68.295	.390
	Hotelling's trace	.348	1.032	9.000	80.000	.422
	Roy's largest root	.212	2.120	3.000	30.000	.119
Shift	Pillai's trace	.433	1.265	12.000	90.000	.253
	Wilks' lambda	.619	1.232	12.000	74.373	.278
	Hotelling's trace	.534	1.188	12.000	80.000	.306
	Roy's largest root	.301	2.256	4.000	30.000	.086
Use of pallets to move equipment	Pillai's trace	.377	2.245	6.000	58.000	.051
	Wilks' lambda	.650	2.244	6.000	56.000	.052
	Hotelling's trace	.497	2.238	6.000	54.000	.053
	Roy's largest root	.392	3.789	3.000	29.000	.021*
Help received	Pillai's trace	.172	.609	9.000	90.000	.787

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
from coworkers to move equipment	Wilks' lambda	.833	.592	9.000	68.295	.799
	Hotelling's trace	.195	.577	9.000	80.000	.812
	Roy's largest root	.157	1.568	3.000	30.000	.218
Lifting boxes	Pillai's trace	.132	.681	6.000	58.000	.666
	Wilks' lambda	.872	.660	6.000	56.000	.682
	Hotelling's trace	.142	.639	6.000	54.000	.699
	Roy's largest root	.095	.919	3.000	29.000	.444
Transferring pallets from one location to another	Pillai's trace	.077	.780	3.000	28.000	.515
	Wilks' lambda	.923	.780	3.000	28.000	.515
	Hotelling's trace	.084	.780	3.000	28.000	.515
	Roy's largest root	.084	.780	3.000	28.000	.515
Lifting objects from an awkward position	Pillai's trace	.097	.491	6.000	58.000	.812
	Wilks' lambda	.905	.478	6.000	56.000	.822
	Hotelling's trace	.103	.465	6.000	54.000	.831
	Roy's largest root	.083	.799	3.000	29.000	.504
Pushing or pulling objects	Pillai's trace	.040	.390	3.000	28.000	.761
	Wilks' lambda	.960	.390	3.000	28.000	.761
	Hotelling's trace	.042	.390	3.000	28.000	.761
	Roy's largest root	.042	.390	3.000	28.000	.761
Bending to pick up an object	Pillai's trace	.241	2.968	3.000	28.000	.049*
	Wilks' lambda	.759	2.968	3.000	28.000	.049*
	Hotelling's trace	.318	2.968	3.000	28.000	.049*
	Roy's largest root	.318	2.968	3.000	28.000	.049*
Performing repetitive tasks	Pillai's trace	.028	.265	3.000	28.000	.850
	Wilks' lambda	.972	.265	3.000	28.000	.850
	Hotelling's trace	.028	.265	3.000	28.000	.850
	Roy's largest root	.028	.265	3.000	28.000	.850
Lifting objects over the head	Pillai's trace	.233	.843	9.000	90.000	.579
	Wilks' lambda	.774	.842	9.000	68.295	.581
	Hotelling's trace	.282	.836	9.000	80.000	.585
	Roy's largest root	.243	2.430	3.000	30.000	.085
Transferring equipment without the use	Pillai's trace	.127	.443	9.000	90.000	.908
	Wilks' lambda	.876	.423	9.000	68.295	.918
	Hotelling's trace	.137	.406	9.000	80.000	.928

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
of lifting equipment	Roy's largest root	.095	.955	3.000	30.000	.427
Standing for a long period of time	Pillai's trace	.118	.609	6.000	58.000	.722
	Wilks' lambda	.882	.604	6.000	56.000	.726
	Hotelling's trace	.133	.599	6.000	54.000	.730
	Roy's largest root	.128	1.239	3.000	29.000	.314
Sitting in one position for an extended period of time	Pillai's trace	.123	.636	6.000	58.000	.701
	Wilks' lambda	.877	.632	6.000	56.000	.704
	Hotelling's trace	.139	.627	6.000	54.000	.708
	Roy's largest root	.134	1.296	3.000	29.000	.294
Ethnicity	Pillai's trace	.595	1.857	12.000	90.000	.051
	Wilks' lambda	.498	1.869	12.000	74.373	.052
	Hotelling's trace	.830	1.844	12.000	80.000	.055
	Roy's largest root	.547	4.103	4.000	30.000	.009*

*$p < .05$

Table 50

Tests of Between-Subjects Effects for Right Knee Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	16.811a	40	.420	1.184	.319
	Intensity	17.407b	40	.435	1.846	.042
	Interference	13.708c	40	.343	1.088	.409
Intercept	Frequency	.021	1	.021	.060	.809
	Intensity	1.281	1	1.281	5.433	.027
	Interference	.138	1	.138	.439	.513
Gender	Frequency	.720	2	.360	1.013	.375
	Intensity	.749	2	.374	1.588	.221
	Interference	.797	2	.399	1.266	.297
Job category	Frequency	.690	3	.230	.648	.590
	Intensity	.658	3	.219	.930	.438
	Interference	.740	3	.247	.784	.512
Shift	Frequency	3.119	4	.780	2.196	.093
	Intensity	1.021	4	.255	1.083	.383
	Interference	2.510	4	.627	1.993	.121
Use of pallets to move equipment	Frequency	2.210	2	1.105	3.112	.059
	Intensity	1.143	2	.572	2.425	.106

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
	Interference	.443	2	.222	.704	.503
Help received from coworkers to move equipment	Frequency	.534	3	.178	.501	.685
	Intensity	.378	3	.126	.534	.662
	Interference	.448	3	.149	.474	.703
Lifting boxes	Frequency	.160	2	.080	.225	.800
	Intensity	.479	2	.239	1.015	.374
	Interference	.000	2	5.155E-5	.000	1.000
Transferring pallets from one location to another	Frequency	.356	1	.356	1.003	.325
	Intensity	.480	1	.480	2.035	.164
	Interference	.463	1	.463	1.470	.235
Lifting objects from an awkward position	Frequency	.207	2	.104	.292	.749
	Intensity	.038	2	.019	.081	.923
	Interference	.380	2	.190	.603	.554
Pushing or pulling objects	Frequency	.406	1	.406	1.143	.294
	Intensity	.026	1	.026	.112	.740
	Interference	.367	1	.367	1.167	.289
Bending to pick up an object	Frequency	1.176	1	1.176	3.313	.079
	Intensity	.036	1	.036	.151	.700
	Interference	2.397	1	2.397	7.611	.010*
Performing repetitive tasks	Frequency	.221	1	.221	.623	.436
	Intensity	.003	1	.003	.013	.911
	Interference	.068	1	.068	.218	.644
Lifting objects over the head	Frequency	1.408	3	.469	1.321	.286
	Intensity	.361	3	.120	.511	.678
	Interference	1.301	3	.434	1.377	.269
Transferring equipment without the use of lifting equipment	Frequency	.347	3	.116	.326	.807
	Intensity	.305	3	.102	.431	.732
	Interference	.324	3	.108	.343	.794
Standing for a long period of time	Frequency	1.175	2	.588	1.654	.208
	Intensity	.027	2	.013	.057	.945
	Interference	.535	2	.267	.849	.438
Sitting in one position for an extended period of time	Frequency	.377	2	.189	.531	.593
	Intensity	.228	2	.114	.484	.621
	Interference	.008	2	.004	.012	.988
Ethnicity	Frequency	1.628	4	.407	1.146	.354
	Intensity	2.717	4	.679	2.881	.039*
	Interference	.923	4	.231	.733	.577
Error	Frequency	10.653	30	.355		

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
	Intensity	7.072	30	.236		
	Interference	9.447	30	.315		
Total	Frequency	50.000	71			
	Intensity	34.000	71			
	Interference	48.000	71			
Corrected total	Frequency	27.465	70			
	Intensity	24.479	70			
	Interference	23.155	70			

*$p < .05$

Tables 51 and 52 present the multivariate effects and univariate effects for left knee discomfort. The findings for left knee discomfort were similar to those obtained for right knee discomfort. Significant differences in left knee discomfort were observed only across frequency of bending to pick up objects. Nearly significant differences were observed across use of pallets to move equipment. Specifically, those participants who more frequently had to bend to pick up objects experienced more interference with their work because of left knee discomfort. Just as previously observed, the participants who used pallets to move equipment and objects had lower intensities of left knee discomfort.

Table 51

Multivariate Tests for Left Knee Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.154	1.703	3.000	28.000	.189
	Wilks' lambda	.846	1.703	3.000	28.000	.189
	Hotelling's trace	.183	1.703	3.000	28.000	.189
	Roy's largest root	.183	1.703	3.000	28.000	.189
Gender	Pillai's trace	.201	1.078	6.000	58.000	.386
	Wilks' lambda	.808	1.047	6.000	56.000	.405
	Hotelling's trace	.226	1.016	6.000	54.000	.425
	Roy's largest root	.151	1.463	3.000	29.000	.245
Job category	Pillai's trace	.236	.854	9.000	90.000	.569

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Wilks' lambda	.780	.817	9.000	68.295	.602
	Hotelling's trace	.263	.779	9.000	80.000	.636
	Roy's largest root	.137	1.368	3.000	30.000	.272
Shift	Pillai's trace	.413	1.197	12.000	90.000	.297
	Wilks' lambda	.629	1.188	12.000	74.373	.307
	Hotelling's trace	.525	1.166	12.000	80.000	.322
	Roy's largest root	.339	2.546	4.000	30.000	.060
Use of pallets to move equipment	Pillai's trace	.349	2.041	6.000	58.000	.074
	Wilks' lambda	.674	2.032	6.000	56.000	.076
	Hotelling's trace	.448	2.018	6.000	54.000	.079
	Roy's largest root	.351	3.390	3.000	29.000	.031*
Help received from coworkers to move equipment	Pillai's trace	.170	.600	9.000	90.000	.794
	Wilks' lambda	.835	.585	9.000	68.295	.805
	Hotelling's trace	.192	.570	9.000	80.000	.818
	Roy's largest root	.157	1.567	3.000	30.000	.218
Lifting boxes	Pillai's trace	.211	1.139	6.000	58.000	.352
	Wilks' lambda	.799	1.107	6.000	56.000	.370
	Hotelling's trace	.239	1.074	6.000	54.000	.390
	Roy's largest root	.161	1.554	3.000	29.000	.222
Transferring pallets from one location to another	Pillai's trace	.077	.778	3.000	28.000	.516
	Wilks' lambda	.923	.778	3.000	28.000	.516
	Hotelling's trace	.083	.778	3.000	28.000	.516
	Roy's largest root	.083	.778	3.000	28.000	.516
Lifting objects from an awkward position	Pillai's trace	.067	.333	6.000	58.000	.917
	Wilks' lambda	.933	.327	6.000	56.000	.920
	Hotelling's trace	.071	.321	6.000	54.000	.923
	Roy's largest root	.070	.681	3.000	29.000	.571
Pushing or pulling objects	Pillai's trace	.050	.496	3.000	28.000	.688
	Wilks' lambda	.950	.496	3.000	28.000	.688
	Hotelling's trace	.053	.496	3.000	28.000	.688
	Roy's largest root	.053	.496	3.000	28.000	.688
Bending to pick up an object	Pillai's trace	.247	3.064	3.000	28.000	.044*
	Wilks' lambda	.753	3.064	3.000	28.000	.044*
	Hotelling's trace	.328	3.064	3.000	28.000	.044*

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
	Roy's largest root	.328	3.064	3.000	28.000	.044*
Performing repetitive tasks	Pillai's trace	.071	.712	3.000	28.000	.553
	Wilks' lambda	.929	.712	3.000	28.000	.553
	Hotelling's trace	.076	.712	3.000	28.000	.553
	Roy's largest root	.076	.712	3.000	28.000	.553
Lifting objects over the head	Pillai's trace	.391	1.498	9.000	90.000	.161
	Wilks' lambda	.648	1.479	9.000	68.295	.173
	Hotelling's trace	.483	1.430	9.000	80.000	.189
	Roy's largest root	.265	2.647	3.000	30.000	.067
Transferring equipment without the use of lifting equipment	Pillai's trace	.144	.504	9.000	90.000	.868
	Wilks' lambda	.861	.482	9.000	68.295	.882
	Hotelling's trace	.156	.462	9.000	80.000	.896
	Roy's largest root	.101	1.013	3.000	30.000	.401
Standing for a long period of time	Pillai's trace	.126	.650	6.000	58.000	.690
	Wilks' lambda	.875	.646	6.000	56.000	.693
	Hotelling's trace	.142	.641	6.000	54.000	.697
	Roy's largest root	.136	1.317	3.000	29.000	.288
Sitting in one position for an extended period of time	Pillai's trace	.063	.313	6.000	58.000	.927
	Wilks' lambda	.938	.304	6.000	56.000	.932
	Hotelling's trace	.065	.294	6.000	54.000	.937
	Roy's largest root	.049	.472	3.000	29.000	.704
Ethnicity	Pillai's trace	.516	1.560	12.000	90.000	.118
	Wilks' lambda	.548	1.582	12.000	74.373	.115
	Hotelling's trace	.712	1.582	12.000	80.000	.114
	Roy's largest root	.519	3.895	4.000	30.000	.012*

*$p < .05$

Table 52

Tests of Between-Subjects Effects for Left Knee Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	18.256	40	.456	.931	.588
	Intensity	17.407	40	.435	1.846	.042
	Interference	13.517	40	.338	1.074	.425
Intercept	Frequency	.048	1	.048	.097	.758
	Intensity	1.281	1	1.281	5.433	.027
	Interference	.157	1	.157	.498	.486
Gender	Frequency	1.057	2	.529	1.079	.353
	Intensity	.749	2	.374	1.588	.221
	Interference	.830	2	.415	1.319	.282
Job category	Frequency	.737	3	.246	.501	.684
	Intensity	.658	3	.219	.930	.438
	Interference	.784	3	.261	.830	.488
Shift	Frequency	4.391	4	1.098	2.240	.088
	Intensity	1.021	4	.255	1.083	.383
	Interference	2.917	4	.729	2.317	.080
Use of pallets to move equipment	Frequency	3.262	2	1.631	3.328	.050
	Intensity	1.143	2	.572	2.425	.106
	Interference	.597	2	.298	.948	.399
Help received from coworkers to move equipment	Frequency	.718	3	.239	.488	.693
	Intensity	.378	3	.126	.534	.662
	Interference	.483	3	.161	.512	.677
Lifting boxes	Frequency	1.312	2	.656	1.339	.277
	Intensity	.479	2	.239	1.015	.374
	Interference	.063	2	.031	.100	.905
Transferring pallets from one location to another	Frequency	.282	1	.282	.576	.454
	Intensity	.480	1	.480	2.035	.164
	Interference	.434	1	.434	1.378	.250
Lifting objects from an awkward position	Frequency	.713	2	.357	.728	.491
	Intensity	.038	2	.019	.081	.923
	Interference	.651	2	.325	1.034	.368
Pushing or pulling objects	Frequency	.690	1	.690	1.408	.245
	Intensity	.026	1	.026	.112	.740
	Interference	.450	1	.450	1.429	.241
Bending to pick up an object	Frequency	.475	1	.475	.969	.333
	Intensity	.036	1	.036	.151	.700
	Interference	2.006	1	2.006	6.374	.017*
Performing repetitive	Frequency	.963	1	.963	1.965	.171

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
tasks	Intensity	.003	1	.003	.013	.911
	Interference	.187	1	.187	.593	.447
Lifting objects over the head	Frequency	3.799	3	1.266	2.584	.072
	Intensity	.361	3	.120	.511	.678
	Interference	1.608	3	.536	1.703	.188
Transferring equipment without the use of lifting equipment	Frequency	.204	3	.068	.138	.936
	Intensity	.305	3	.102	.431	.732
	Interference	.097	3	.032	.102	.958
Standing for a long period of time	Frequency	1.886	2	.943	1.925	.164
	Intensity	.027	2	.013	.057	.945
	Interference	.671	2	.335	1.066	.357
Sitting in one position for an extended period of time	Frequency	.217	2	.109	.222	.803
	Intensity	.228	2	.114	.484	.621
	Interference	.004	2	.002	.006	.994
Ethnicity	Frequency	2.055	4	.514	1.048	.399
	Intensity	2.717	4	.679	2.881	.039*
	Interference	1.050	4	.263	.834	.514
Error	Frequency	14.702	30	.490		
	Intensity	7.072	30	.236		
	Interference	9.441	30	.315		
Total	Frequency	59.000	71			
	Intensity	34.000	71			
	Interference	49.000	71			
Corrected total	Frequency	32.958	70			
	Intensity	24.479	70			
	Interference	22.958	70			

*$p < .05$

Tables 53 and 54 present the multivariate effects and univariate effects for right lower leg discomfort. There were no significant group differences across right lower leg discomfort. Only shift had a nearly significant effect on right lower leg discomfort. Specifically, there was greater intensity of lower leg discomfort among those participants who worked the rotating day/night and permanent night shifts, but this did not redound to interference with work.

Table 53

Multivariate Tests for Right Lower Leg Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.077	.776	3.000	28.000	.517
	Wilks' lambda	.923	.776	3.000	28.000	.517
	Hotelling's trace	.083	.776	3.000	28.000	.517
	Roy's largest root	.083	.776	3.000	28.000	.517
Gender	Pillai's trace	.173	.913	6.000	58.000	.492
	Wilks' lambda	.830	.911	6.000	56.000	.494
	Hotelling's trace	.201	.907	6.000	54.000	.497
	Roy's largest root	.184	1.779	3.000	29.000	.173
Job category	Pillai's trace	.205	.732	9.000	90.000	.679
	Wilks' lambda	.803	.717	9.000	68.295	.692
	Hotelling's trace	.236	.701	9.000	80.000	.707
	Roy's largest root	.188	1.876	3.000	30.000	.155
Shift	Pillai's trace	.513	1.546	12.000	90.000	.122
	Wilks' lambda	.537	1.643	12.000	74.373	.098
	Hotelling's trace	.771	1.713	12.000	80.000	.079
	Roy's largest root	.624	4.681	4.000	30.000	.005*
Use of pallets to move equipment	Pillai's trace	.248	1.368	6.000	58.000	.243
	Wilks' lambda	.764	1.342	6.000	56.000	.254
	Hotelling's trace	.292	1.315	6.000	54.000	.267
	Roy's largest root	.218	2.111	3.000	29.000	.121
Help received from coworkers to move equipment	Pillai's trace	.121	.419	9.000	90.000	.922
	Wilks' lambda	.881	.406	9.000	68.295	.928
	Hotelling's trace	.133	.395	9.000	80.000	.934
	Roy's largest root	.118	1.183	3.000	30.000	.333
Lifting boxes	Pillai's trace	.151	.791	6.000	58.000	.581
	Wilks' lambda	.853	.774	6.000	56.000	.594
	Hotelling's trace	.168	.756	6.000	54.000	.607
	Roy's largest root	.133	1.281	3.000	29.000	.299
Transferring pallets from one location to	Pillai's trace	.014	.136	3.000	28.000	.937
	Wilks' lambda	.986	.136	3.000	28.000	.937
	Hotelling's trace	.015	.136	3.000	28.000	.937

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
another	Roy's largest root	.015	.136	3.000	28.000	.937
Lifting objects from an awkward position	Pillai's trace	.145	.757	6.000	58.000	.607
	Wilks' lambda	.858	.740	6.000	56.000	.620
	Hotelling's trace	.161	.723	6.000	54.000	.633
	Roy's largest root	.127	1.227	3.000	29.000	.318
Pushing or pulling objects	Pillai's trace	.111	1.160	3.000	28.000	.343
	Wilks' lambda	.889	1.160	3.000	28.000	.343
	Hotelling's trace	.124	1.160	3.000	28.000	.343
	Roy's largest root	.124	1.160	3.000	28.000	.343
Bending to pick up an object	Pillai's trace	.050	.496	3.000	28.000	.688
	Wilks' lambda	.950	.496	3.000	28.000	.688
	Hotelling's trace	.053	.496	3.000	28.000	.688
	Roy's largest root	.053	.496	3.000	28.000	.688
Performing repetitive tasks	Pillai's trace	.060	.596	3.000	28.000	.623
	Wilks' lambda	.940	.596	3.000	28.000	.623
	Hotelling's trace	.064	.596	3.000	28.000	.623
	Roy's largest root	.064	.596	3.000	28.000	.623
Lifting objects over the head	Pillai's trace	.415	1.606	9.000	90.000	.126
	Wilks' lambda	.614	1.684	9.000	68.295	.110
	Hotelling's trace	.582	1.725	9.000	80.000	.097
	Roy's largest root	.493	4.929	3.000	30.000	.007*
Transferring equipment without the use of lifting equipment	Pillai's trace	.226	.816	9.000	90.000	.603
	Wilks' lambda	.785	.794	9.000	68.295	.623
	Hotelling's trace	.259	.769	9.000	80.000	.645
	Roy's largest root	.191	1.909	3.000	30.000	.149
Standing for a long period of time	Pillai's trace	.146	.760	6.000	58.000	.604
	Wilks' lambda	.856	.757	6.000	56.000	.606
	Hotelling's trace	.167	.753	6.000	54.000	.610
	Roy's largest root	.158	1.524	3.000	29.000	.229
Sitting in one position for an extended period of time	Pillai's trace	.140	.725	6.000	58.000	.631
	Wilks' lambda	.863	.713	6.000	56.000	.640
	Hotelling's trace	.156	.701	6.000	54.000	.650
	Roy's largest root	.133	1.289	3.000	29.000	.297

	Effect	Value	*F*	Hypothesis *df*	Error *df*	Sig.
Ethnicity	Pillai's trace	.294	.815	12.000	90.000	.634
	Wilks' lambda	.720	.820	12.000	74.373	.629
	Hotelling's trace	.370	.823	12.000	80.000	.626
	Roy's largest root	.313	2.345	4.000	30.000	.077

*$p < .05$

Table 54

Tests of Between-Subjects Effects for Right Lower Leg Discomfort

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected Model	Frequency	12.629	40	.316	.556	.959
	Intensity	15.125	40	.378	1.453	.145
	Interference	15.268	40	.382	1.397	.172
Intercept	Frequency	.246	1	.246	.434	.515
	Intensity	.105	1	.105	.403	.530
	Interference	.008	1	.008	.031	.862
Gender	Frequency	.839	2	.420	.739	.486
	Intensity	.561	2	.281	1.078	.353
	Interference	1.224	2	.612	2.240	.124
Job category	Frequency	.784	3	.261	.460	.712
	Intensity	.649	3	.216	.832	.487
	Interference	.570	3	.190	.695	.562
Shift	Frequency	.604	4	.151	.266	.897
	Intensity	2.711	4	.678	2.606	.056
	Interference	1.274	4	.319	1.166	.345
Use of pallets to move equipment	Frequency	1.071	2	.536	.943	.401
	Intensity	.391	2	.195	.751	.481
	Interference	1.201	2	.600	2.197	.129
Help received from coworkers to move equipment	Frequency	.976	3	.325	.573	.637
	Intensity	.834	3	.278	1.069	.377
	Interference	.494	3	.165	.602	.619
Lifting boxes	Frequency	.182	2	.091	.160	.853
	Intensity	.445	2	.222	.854	.436
	Interference	.363	2	.182	.665	.522
Transferring pallets from one location to another	Frequency	.126	1	.126	.221	.642
	Intensity	.035	1	.035	.136	.715
	Interference	.009	1	.009	.031	.861
Lifting objects from an awkward	Frequency	1.170	2	.585	1.030	.369
	Intensity	.360	2	.180	.692	.509

Source	DV	Type III sum of squares	*df*	*MS*	*F*	Sig.
position	Interference	1.009	2	.505	1.847	.175
Pushing or pulling objects	Frequency	1.124	1	1.124	1.980	.170
	Intensity	.465	1	.465	1.786	.191
	Interference	.962	1	.962	3.521	.070
Bending to pick up an object	Frequency	.735	1	.735	1.295	.264
	Intensity	.088	1	.088	.339	.565
	Interference	.415	1	.415	1.518	.227
Performing repetitive tasks	Frequency	.012	1	.012	.021	.887
	Intensity	.340	1	.340	1.306	.262
	Interference	.002	1	.002	.008	.930
Lifting objects over the head	Frequency	2.210	3	.737	1.298	.293
	Intensity	.268	3	.089	.344	.794
	Interference	2.911	3	.970	3.552	.026
Transferring equipment without the use of lifting equipment	Frequency	.883	3	.294	.518	.673
	Intensity	.685	3	.228	.878	.463
	Interference	1.093	3	.364	1.333	.282
Standing for a long period of time	Frequency	.191	2	.095	.168	.846
	Intensity	.987	2	.493	1.896	.168
	Interference	.440	2	.220	.805	.457
Sitting in one position for an extended period of time	Frequency	.516	2	.258	.455	.639
	Intensity	.612	2	.306	1.177	.322
	Interference	.842	2	.421	1.540	.231
Ethnicity	Frequency	.888	4	.222	.391	.813
	Intensity	2.331	4	.583	2.240	.088
	Interference	.449	4	.112	.411	.799
Error	Frequency	17.033	30	.568		
	Intensity	7.805	30	.260		
	Interference	8.197	30	.273		
Total	Frequency	45.000	71			
	Intensity	27.000	71			
	Interference	37.000	71			
Corrected total	Frequency	29.662	70			
	Intensity	22.930	70			
	Interference	23.465	70			

*$p < .05$

Tables 55 and 56 present the multivariate effects and univariate effects for left lower leg discomfort. Left lower leg discomfort findings resembled those obtained for

right lower leg discomfort. There were no significant group differences across left lower leg discomfort, with only shift having a nearly significant effect on left lower leg discomfort. There was greater intensity of lower left leg discomfort among those participants who worked the rotating day/night and permanent night shifts, but this did not affect interference with work.

Table 55

Multivariate Tests for Left Lower Leg Discomfort

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Intercept	Pillai's trace	.082	.835	3.000	28.000	.486
	Wilks' lambda	.918	.835	3.000	28.000	.486
	Hotelling's trace	.089	.835	3.000	28.000	.486
	Roy's largest root	.089	.835	3.000	28.000	.486
Gender	Pillai's trace	.082	.412	6.000	58.000	.868
	Wilks' lambda	.919	.404	6.000	56.000	.874
	Hotelling's trace	.088	.395	6.000	54.000	.879
	Roy's largest root	.080	.774	3.000	29.000	.518
Job category	Pillai's trace	.244	.884	9.000	90.000	.542
	Wilks' lambda	.768	.869	9.000	68.295	.557
	Hotelling's trace	.286	.848	9.000	80.000	.574
	Roy's largest root	.215	2.152	3.000	30.000	.114
Shift	Pillai's trace	.507	1.525	12.000	90.000	.130
	Wilks' lambda	.519	1.742	12.000	74.373	.075
	Hotelling's trace	.876	1.946	12.000	80.000	.041*
	Roy's largest root	.815	6.116	4.000	30.000	.001*
Use of pallets to move equipment	Pillai's trace	.317	1.823	6.000	58.000	.110
	Wilks' lambda	.692	1.890	6.000	56.000	.099
	Hotelling's trace	.433	1.950	6.000	54.000	.089
	Roy's largest root	.402	3.883	3.000	29.000	.019
Help received from coworkers to move	Pillai's trace	.177	.626	9.000	90.000	.772
	Wilks' lambda	.829	.606	9.000	68.295	.787
	Hotelling's trace	.198	.588	9.000	80.000	.803

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
equipment	Roy's largest root	.151	1.512	3.000	30.000	.232
Lifting boxes	Pillai's trace	.058	.290	6.000	58.000	.939
	Wilks' lambda	.943	.280	6.000	56.000	.944
	Hotelling's trace	.060	.270	6.000	54.000	.948
	Roy's largest root	.037	.359	3.000	29.000	.783
Transferring pallets from one location to another	Pillai's trace	.047	.455	3.000	28.000	.716
	Wilks' lambda	.953	.455	3.000	28.000	.716
	Hotelling's trace	.049	.455	3.000	28.000	.716
	Roy's largest root	.049	.455	3.000	28.000	.716
Lifting objects from an awkward position	Pillai's trace	.027	.130	6.000	58.000	.992
	Wilks' lambda	.974	.126	6.000	56.000	.993
	Hotelling's trace	.027	.122	6.000	54.000	.993
	Roy's largest root	.019	.181	3.000	29.000	.908
Pushing or pulling objects	Pillai's trace	.058	.576	3.000	28.000	.636
	Wilks' lambda	.942	.576	3.000	28.000	.636
	Hotelling's trace	.062	.576	3.000	28.000	.636
	Roy's largest root	.062	.576	3.000	28.000	.636
Bending to pick up an object	Pillai's trace	.001	.010	3.000	28.000	.998
	Wilks' lambda	.999	.010	3.000	28.000	.998
	Hotelling's trace	.001	.010	3.000	28.000	.998
	Roy's largest root	.001	.010	3.000	28.000	.998
Performing repetitive tasks	Pillai's trace	.124	1.317	3.000	28.000	.288
	Wilks' lambda	.876	1.317	3.000	28.000	.288
	Hotelling's trace	.141	1.317	3.000	28.000	.288
	Roy's largest root	.141	1.317	3.000	28.000	.288
Lifting objects over the head	Pillai's trace	.408	1.573	9.000	90.000	.135
	Wilks' lambda	.621	1.642	9.000	68.295	.121
	Hotelling's trace	.565	1.674	9.000	80.000	.109
	Roy's largest root	.467	4.666	3.000	30.000	.009
Transferring equipment without the use of lifting equipment	Pillai's trace	.142	.497	9.000	90.000	.873
	Wilks' lambda	.863	.473	9.000	68.295	.888
	Hotelling's trace	.153	.453	9.000	80.000	.902
	Roy's largest root	.085	.847	3.000	30.000	.479

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.
Standing for a long period of time	Pillai's trace	.103	.522	6.000	58.000	.789
	Wilks' lambda	.898	.515	6.000	56.000	.794
	Hotelling's trace	.113	.507	6.000	54.000	.800
	Roy's largest root	.106	1.023	3.000	29.000	.397
Sitting in one position for an extended period of time	Pillai's trace	.120	.619	6.000	58.000	.714
	Wilks' lambda	.883	.601	6.000	56.000	.728
	Hotelling's trace	.129	.582	6.000	54.000	.743
	Roy's largest root	.091	.884	3.000	29.000	.461
Ethnicity	Pillai's trace	.278	.765	12.000	90.000	.684
	Wilks' lambda	.732	.777	12.000	74.373	.672
	Hotelling's trace	.354	.786	12.000	80.000	.663
	Roy's largest root	.313	2.350	4.000	30.000	.077

*$p < .05$

Table 56

Tests of Between-Subjects Effects for Left Lower Leg Discomfort

Source	Dependent Variable	Type III sum of squares	*df*	*MS*	*F*	Sig.
Corrected model	Frequency	13.066	40	.327	.799	.749
	Intensity	13.874	40	.347	1.088	.410
	Interference	13.803	40	.345	1.087	.410
Intercept	Frequency	.044	1	.044	.108	.745
	Intensity	.030	1	.030	.095	.760
	Interference	.060	1	.060	.188	.668
Gender	Frequency	.852	2	.426	1.043	.365
	Intensity	.186	2	.093	.291	.750
	Interference	.719	2	.359	1.133	.336
Job category	Frequency	.832	3	.277	.678	.572
	Intensity	.881	3	.294	.921	.442
	Interference	.402	3	.134	.422	.739
Shift	Frequency	.594	4	.149	.364	.833
	Intensity	1.940	4	.485	1.521	.221
	Interference	.629	4	.157	.495	.739
Use of pallets to move equipment	Frequency	.719	2	.359	.879	.425
	Intensity	.078	2	.039	.122	.886
	Interference	.471	2	.235	.742	.485
Help received from	Frequency	1.203	3	.401	.982	.415

Source	Dependent Variable	Type III sum of squares	*df*	*MS*	*F*	Sig.
coworkers to move equipment	Intensity	1.043	3	.348	1.090	.368
	Interference	.430	3	.143	.452	.718
Lifting boxes	Frequency	.106	2	.053	.130	.878
	Intensity	.287	2	.143	.450	.642
	Interference	.171	2	.085	.269	.766
Transferring pallets from one location to another	Frequency	.382	1	.382	.936	.341
	Intensity	.104	1	.104	.327	.572
	Interference	.081	1	.081	.256	.617
Lifting objects from an awkward position	Frequency	.081	2	.041	.099	.906
	Intensity	.003	2	.001	.004	.996
	Interference	.052	2	.026	.082	.921
Pushing or pulling objects	Frequency	.449	1	.449	1.100	.303
	Intensity	.012	1	.012	.038	.847
	Interference	.079	1	.079	.248	.622
Bending to pick up an object	Frequency	3.120E-5	1	3.120E-5	.000	.993
	Intensity	.004	1	.004	.012	.914
	Interference	.003	1	.003	.008	.929
Performing repetitive tasks	Frequency	.499	1	.499	1.222	.278
	Intensity	.631	1	.631	1.978	.170
	Interference	.062	1	.062	.195	.662
Lifting objects over the head	Frequency	.666	3	.222	.543	.657
	Intensity	.161	3	.054	.168	.917
	Interference	1.869	3	.623	1.963	.141
Transferring equipment without the use of lifting equipment	Frequency	.540	3	.180	.441	.726
	Intensity	.504	3	.168	.527	.667
	Interference	.680	3	.227	.714	.551
Standing for a long period of time	Frequency	.352	2	.176	.431	.654
	Intensity	.424	2	.212	.665	.522
	Interference	.076	2	.038	.119	.888
Sitting in one position for an extended period of time	Frequency	.641	2	.321	.784	.466
	Intensity	.760	2	.380	1.192	.317
	Interference	.623	2	.311	.981	.387
Ethnicity	Frequency	.245	4	.061	.150	.962
	Intensity	1.619	4	.405	1.270	.304
	Interference	.054	4	.014	.043	.996
Error	Frequency	12.258	30	.409		
	Intensity	9.563	30	.319		
	Interference	9.521	30	.317		
Total	Frequency	38.000	71			

Source	Dependent Variable	Type III sum of squares	*df*	*MS*	*F*	Sig.
	Intensity	28.000	71			
	Interference	36.000	71			
Corrected Total	Frequency	25.324	70			
	Intensity	23.437	70			
	Interference	23.324	70			

*$p < .05$

Summary

This study was about the health concerns of warehouse workers and the degree to which these concerns interfere with their work. The sample consisted of 71 participants across various demographic groups, job categories, and job tasks who answered a questionnaire to determine their body part-specific health concerns and the ways in which they may affect their work. The predominant concerns involved discomfort in the upper back, lower back, right knee, left knee, right lower leg, and left lower leg.

A MANOVA conducted on the data set, revealed group differences across the demographic and work variables among the three highly correlated dependent variables. Neck discomfort was most associated with work conditions such as sitting in place and lifting boxes, whereas shoulder discomfort was most associated with bending over to lift boxes. Most often observed were upper back difficulties among the male participants and among permanent evening or night shift participants. Discomfort in right upper arm was greater among the female participants, whereas discomfort in the left upper arm was greater among the participants who did not use pallets to move objects in the warehouse. Work tasks such as sitting in the same position and bending over to pick up objects contributed to lower back discomfort.

Noted, were some counterintuitive findings with regard to forearm and wrist discomfort. The participants who received more help, lifted boxes less frequently, and transferred pallets had higher levels of forearm and wrist discomfort. These findings were unexpected and unprecedented in the corpus of literature on this topic. Hip/buttock discomfort was greater among the female participants, the participants on permanent evening or night shifts, and the participants who very frequently had to lift boxes. Thigh discomfort was the most intense for those participants who received help from their coworkers, whereas lower leg discomfort was the most intense for those participants who worked that rotating day/night and permanent night shifts. Observed consistently, was knee discomfort among those participants who very frequently had to bend to pick up objects.

The findings that emerged were intuitive and extraordinary. In many ways, they concurred with the current state of knowledge in industrial health, but there also were a number of unexpected findings. The next chapter includes the analyzed findings and synthesizes them into a coherent, contextualized whole. A discussion of the results and the implications for social change is also included.

CHAPTER 5: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

The study was an investigation of discomfort among warehouse workers across various demographic groups and working conditions. Seventy-one warehouse workers completed questionnaires to assess their demographics, working conditions, and discomfort in particular body parts. The questionnaire sought to determine the frequency of, intensity of, and work interference resulting from discomfort in core and peripheral body parts: neck, shoulders, upper arms, forearms, wrists, upper back, lower back, hip/buttock, thighs, knees, and lower legs respectively in the previous week.

Conducted MANOVAs determined the multivariate and between-group effects of the demographic variables and working conditions/tasks upon frequency of discomfort, intensity of discomfort, and work interference because of discomfort in each body part. The previous chapters presented the results of these inferential statistics across discomfort in each body part. This chapter includes the dissected, discussed, and interpreted as individual data points and in light of the complete analysis, results. Following the results, are the implications drawn from the discussions, culminating in a set of conclusions. Divided according to body part discomfort, the discussion takes left and right body parts together, because the findings across contralateral body parts were consonant more often than not.

Discussion of Body Part Discomfort

Neck Discomfort

Neck discomfort was relatively uncommon in the sample, appearing in less than 10% of the respondents. At most, there was only slight neck discomfort and only about 10% found that their neck discomfort interfered with their work. Because the neck muscles are not necessarily employed in most warehouse personnel functions, this response level was more or less as expected. Neck discomfort, although observed minimally, was more common among the warehouse workers and the forklift operators. Stockroom staff had less neck discomfort because there was little heavy lifting involved and because unlike the forklift operators, they did not keep their heads oriented in the same positions for protracted periods.

The participants who had to stand for long periods also had more frequent neck discomfort, as did the participants who had to lift boxes very frequently. These activities tend to cause neck strain because they can be very physically demanding and strenuous. Anyone who has had to stand for several hours at a time will likely attest to this fact. Though only a small proportion of the sample suffered from neck discomfort, those participants who did also found that their neck discomfort interfered with their work on some level. This problem necessitates a means for treating and preventing neck discomfort among warehouse personnel.

Shoulder Discomfort

Shoulder discomfort was very common among the respondents, with approximately half of the respondents reporting some frequency of shoulder discomfort.

Many participants who experienced occasional shoulder discomfort did not even consider it even slightly uncomfortable. The proportion of participants (33%) who found shoulder discomfort as interference in work more or less matched the proportion of participants who found it somewhat uncomfortable. Still, nearly one third of the respondents experienced work interference because of shoulder discomfort, whether one or both shoulders were involved. There was a slightly higher percentage of discomfort across variables for right shoulder discomfort, a possible reason being that the presumably right-handed majority of participants used their right shoulders a little more than their left shoulders.

Bending to pick up objects evinced a significant group difference in shoulder discomfort across the sample. This group experienced more intense shoulder pain on both sides, and it interfered with their work. This finding was interesting because in good lifting form, the shoulder muscles often not employed as much. This finding led to the possibility that the personnel who had higher levels shoulder discomfort were not lifting low-lying objects properly. Pallets typically lifted at or above shoulder level, also contributed to shoulder discomfort.

Upper Arm Discomfort

About one fifth of the participants reported some frequency of upper arm discomfort. The intensity of discomfort was slight, but it still resulted in slight interference with work for nearly 20% of the participants. Levels were slightly lower for left upper arm discomfort than right upper arm discomfort for quite possible the same

reason as that presented for the shoulders, namely, that right upper arms were preferentially employed slightly more than left upper arms.

Right upper arm discomfort was greater in frequency among the female participants, although this did not seem to interfere with their work. Left upper arm discomfort was greater among those participants who did not use pallets to move stock. Because they did not use their shoulders in lifting the pallets, they resorted to using mostly their upper arm muscles to lift and continue lifting the objects from origin to destination. There were notably little significant group differences in upper arm discomfort. It seems demographic and work variables did not predict or affect discomfort. Other variables may more effectively predict upper arm discomfort.

Upper Back Discomfort

The majority of participants presented with upper back discomfort. More than half had upper back discomfort one or two times a week; about one fifth of the participants had upper back pain three or four times a week, whereas only a minority had upper back pain every day. Nearly three quarters of the sample reported some level of interference with work because of upper back discomfort. These problems were the highest levels of discomfort observed across all body parts and thus merited especially close investigation.

The findings showed that upper back discomfort interfered with work for the men in particular, but not for the women. This finding, specific to gender, not job responsibilities, may not have been confounded by task performed and may have referred to gender itself. The men who experienced upper back discomfort experienced significantly more interference with their work than the women did. There did not appear

to be any apparent gender differences that could explain this phenomenon, so without further research, it cannot be explained definitively. Upper back discomfort also was more frequent among the participants who worked the permanent evening or permanent night shift. This finding may have had something to do with sleeping during the day on a regular basis. Nevertheless, this did not have any significant effect on interference with work.

Only demographics and shifts, no particular tasks, were associated with upper back discomfort. Upper back discomfort was reasonably prevalent in the sample, but the variables did not sufficiently explain it. The nature of the jobs in question may predispose these participants to greater levels of upper back discomfort. This appears to be a profitable line of inquiry considering the stark absence of task group differences in upper back discomfort.

Forearm Discomfort

In contrast to the previously mentioned body parts, forearm discomfort was relatively uncommon among the participants. Only 10% claimed to have had some form of forearm discomfort in the previous week. In nearly all cases, the forearm discomfort was infrequent and slight in intensity.

The few participants who did experience forearm discomfort had some rather unusual and unexpected characteristics. The participants who used pallets to move equipment had higher levels of work interference because of forearm discomfort. The participants who received help lifting pallets also had higher levels of interference in their work because of forearm discomfort. In theory, the warehouse employees should have

had little reason to experience forearm discomfort because when lifting heavy objects, the muscles in the upper arm, shoulders, and core are used. (Bridger,2003). A working hypothesis in this regard was that the participants who experienced forearm discomfort simply were not lifting with the right form.

Another conjecture is that the use of pallets may be associated with forearm discomfort. The participants who regularly lifted pallets seemed to have the greatest discomfort in terms of frequency and intensity, as well as subsequent work interference. This discomfort also may have had something to do with lifting form, which should have required the use of the upper arm and shoulder muscles instead of the forearm muscles. An alternative explanation could have been that not bad form, but simply weaker upper arm and shoulder muscles, such that the use of smaller muscle groups in the forearms, were lifting and transferring objects as needed. Because the participants who lifted boxes less often had more forearm discomfort, they may simply have lacked strength because they did not lift as many boxes. They may have experienced forearm discomfort during the few times when they were required to lift boxes. Further investigation will be necessary to determine which proposition best fits the experiences of these warehouse personnel.

Lower Back Discomfort

Similar to upper back discomfort, lower back discomfort was common among the participants, with more than three quarters of them experiencing some lower back discomfort in the past week. Although the majority of the participants experienced only slight discomfort, many of them also experienced moderate to intense lower back

discomfort. Ten percent of the participants reported that lower back discomfort interfered with a substantial amount of their work. Lower back discomfort was as serious a concern, if not more so, as upper back pain.

Though lower back discomfort was nearly as prevalent as upper back discomfort, it was not from the same sources. The participants who very frequently had to lift objects over their heads had more intense lower back discomfort and experienced more work interference because of lower back discomfort. This discomfort could have been the result of bad lifting form among the warehouse personnel.

Another notable finding was that intensity of lower back discomfort and work interference resulting from lower back discomfort was higher among the participants who very frequently had to sit in place without changing position for long periods. Because there was nothing wrong with sitting in place *per se*, the specific sitting positions of the participants may have caused lower back discomfort. They may also have been slouching regularly in a workspace that was not ergonomically suitable to their needs.

Wrist Discomfort

The findings for wrist discomfort paralleled those for forearm discomfort. There was slightly more reported wrist discomfort among the participants, with about one fifth of them reporting some interference at work because of wrist discomfort. Left wrist discomfort was slightly less prevalent than right wrist discomfort, a finding likely resulting from differences in handedness and muscle recruitment.

Wrist discomfort was the highest among the warehouse workers, who experienced more intense wrist discomfort that interfered more with their work. Wrist pain was higher

among the participants who only sometimes lifted boxes, as compared to the participants who lifted boxes more frequently. The same observed findings for the participants who infrequently lifted objects over their heads and those individuals who sat in the same position for extended periods. They experienced more intense wrist pain and greater interference with work because of wrist discomfort. The participants who received more help from coworkers had more intense wrist discomfort. These findings were in line with the previous hypothesis about bad lifting form. The participants who tended to sit more often and lift less often used their wrist muscles either when they had to lift because of bad lifting form, they were unaccustomed to lifting heavy weights and simply recruited these smaller muscle groups in the wrist, or possibly a combination of both reasons.

Hip/Buttock Discomfort

Discomfort in the hip/buttock region was relatively uncommon among the participants, with less than 10% of them presenting with hip/buttock discomfort. Observed, was a remarkable gender difference in levels of work interference because of hip/buttock discomfort. The female participants experienced more interference in their work because of hip/buttock discomfort, despite having the equivalent frequency and intensity of discomfort in the hip/buttock areas to that experienced by the male participants. Hip/buttock discomfort was more likely to affect the quality and productivity of the female warehouse personnel. Hip/buttock discomfort also was more intense among the participants who did not use pallets to move objects around; however, the participants who lifted objects over their heads more often, experienced discomfort.

Focusing on proper lifting techniques through prior training will contribute to lower levels of hip/buttock discomfort.

Another revealing finding was unusual group difference across shift workers. The participants who worked the permanent night or permanent evening shift experienced greater hip/buttock interference with work, despite greater intensity of hip/buttock discomfort among the participants who worked the rotating day/night shift. Perhaps having to work at night regularly contributed to greater discomfort in the hip/buttock area. The more demanding work conditions may have induced greater stress in the core muscles, subsequently causing hip/buttock discomfort.

Thigh Discomfort

Thigh discomfort was one of the least observed ailments among the participants, having the lowest frequencies and intensities. Only a few participants reported slight interference at worst. Observed were essentially the same levels of discomfort across the contralateral thigh area.

The demographic and work variables in the model generally did not contribute much to the dependent variables on thigh discomfort, with the exception of help received from coworkers. The participants who received more help from coworkers had more intense thigh discomfort, but the discomfort did not seem to correlate with interference with their work. In general, perhaps the workers who needed and received help from their coworkers were generally weaker or may have had to lift heavier weights, either/both of which likely contributed to thigh discomfort. Thigh discomfort was not associated very

much with the variables studied but may have been associated with other individual differences.

Knee Discomfort

As one might expect, knee discomfort was common among the warehouse personnel. About half of all of the participants had noted some level of knee discomfort in the previous week. For most of these participants, the pain was only slightly uncomfortable, but nearly one sixth of the participants experiencing discomfort reported moderate discomfort in their knees. About half of the participants reported slight interference with their work, but some noted substantial interference with their work because of knee discomfort. Given the relatively high proportions of participants experiencing knee discomfort, identifying group differences in knee discomfort provided interesting data.

One particular variable that was a robust and reliable predictor of knee discomfort across both knees among the participants was the frequency of bending to pick up objects. The participants who more frequently had to bend to pick up objects experienced more frequent discomfort that also interfered more with their work. This finding was expected because bending to lift objects may strain the patellar joint and lead to a higher incidence of discomfort in the knee. The participants who used pallets actually had lower levels of knee discomfort. Curiously, the Asian participants had more frequent knee discomfort, perhaps because Asian ethnicity may be a latent representation of smaller height and shorter legs. With smaller legs, more power must be exerted to lift objects when the knees are bent because the levers (i.e., thigh and lower leg) are shorter, thus

exerting greater stress on the fulcrum (i.e., the knee). Future demographic and epidemiological research may best address this working hypothesis.

Lower Leg Discomfort

Lower leg discomfort was surprisingly common among the participants, with more than one third of the sample presenting with lower leg discomfort in the past week. Fewer than half of the participants who reported lower leg discomfort found it uncomfortable and equally divided were the participants who did report discomfort, between slight and moderate discomfort. The proportions of work interference because of lower leg discomfort matched those obtained for frequency of lower leg discomfort, suggesting that the frequency of lower leg discomfort was the most often associated with work interference caused by lower leg discomfort. An alternative hypothesis was that the participants underreported the intensity of lower leg discomfort. Essentially, lower left and lower right leg reported the same findings.

The group differences in lower leg discomfort were astounding in that there was only one significant predictor of lower leg discomfort among the variables measured: shift taken. Specifically, the participants who worked the permanent night shift and the rotating day/night shift had more intense lower leg discomfort, but this discomfort did not redound to work interference. Perhaps the participants' work schedule resulted in more intense lower leg discomfort because of differences in the activities performed by warehouse personnel on those shifts and those performed during regular working hours or because of a difference in the volume of work handled. In any case, the differences in activities did not affect work performance anyway. Lower leg discomfort was so

prevalent, yet not predicted by most of the variables, that other individual differences could have been better predictors of lower leg discomfort. Lower leg discomfort was relatively indiscriminate in affecting the participants and should be a general concern for warehouse personnel.

Recommendations for Further Study

The findings showed that discomfort was greater in both shoulders, the upper back, the lower back, both knees, and both legs of the warehouse personnel. Paying greater attention to the primary prevention of discomfort in these areas is important. Stretching before work can reduce discomfort and injury in these areas, redounding in greater productivity and well-being among the participants. This finding also may be useful to workers in industrial health workers, and it may lead to the identification of health concerns among warehouse personnel. Further research will help to determine what specifically leads to discomfort in these areas and how to perform prophylaxis and prevention on a regular basis.

Some of the differences in body part discomfort among the participants were associated with various demographic variables, such as upper back pain interfering with work more often among the male participants and hip/buttock pain interfering with work more often among the female participants. Because these findings did not reveal task differences, it is unlikely that gender in the sample served as a latent variable for task performed; rather, it simply referred to gender and all associated phenomena. Paying special attention to preventing upper back pain in males and hip/buttock pain in females is essential. The specific etiology of this group difference is a topic worthy of future

investigation. Ethnicity also predicted body part discomfort, such as knee discomfort among the Asian participants.

Shift was another unexpected predictor, with permanent evening and night shifts contributing to greater upper back discomfort and hip/buttock discomfort. Furthermore, the participants who worked the rotating day/night and permanent night shift had higher levels of lower leg discomfort. These findings may have been the result of differences in workload and responsibilities across shifts. Nevertheless, these findings make the process of treatment and prevention easier and more efficient. Exploring the mechanism of how shift affects WRMSD in further research is valuable information.

The incidence of certain body part discomfort, such as in the upper arms, upper back, thighs, and lower legs, was not well predicted by the variables. This does not mean that future research should pay less attention to these areas. Rather, it is of great importance to identify what leads to discomfort in these areas, particularly the upper back and lower legs, because of the high incidence among the entire target population of warehouse personnel. Task differences generally do not contribute to discomfort in these areas.

The variables in this study did not predict the discomfort incidents of certain body part, such as upper arms, upper back, thighs, and lower legs. This does not mean that future research should pay less attention to these areas. Rather, it is of great importance to identify what leads to discomfort in these areas, particularly the upper back and lower legs because of their higher levels of incidence in the sample and possibly also in the

target population of warehouse personnel. Task differences generally do not contribute to discomfort in these areas.

Recommendations for Action

One finding was that the participants experienced more discomfort in the joints and muscles of the core and center areas when they performed strenuous tasks. This finding may lead to the development of ways to prevent discomfort that interferes with work by showing which personnel are more likely to experience discomfort in core regions. Workers who remain standing or seated in the same positions should be encouraged to stretch and move around to prevent discomfort in these areas.

The findings also provided evidence supporting the use of pallets in lifting and transferring objects. The participants in this study who used pallets had lower levels of discomfort in the hip/buttock, upper arm, and knee areas. Pallets distribute the weight of objects more evenly and allow for the cooperative lifting of objects, their advantages about productivity notwithstanding. Thus, in order to maximize efficiency and health among workers across the board, pallets are a worthwhile investment for use in warehouse processes.

Bending up to pick up objects is a constant generator of body part discomfort. The shoulders, lower back, and knees undergo more discomfort among workers who bend to pick up objects more often. Because bending to lift objects is an inevitable aspect of their jobs, warehouse workers are encouraged to stretch and maintain good lifting form. Warehouse personnel are also encouraged to ask for help when lifting particularly heavy objects from lower areas in order to reduce strain.

Perhaps the most important finding was the supreme importance of good lifting to avoid WRMSDs. Bad lifting form results in joint and muscle discomfort in the shoulder, forearms, lower back, and wrist areas. In general, the forearms and wrist should not even be involved in the lifting process. Aching forearms and inflamed wrists generally point to bad lifting form. Training personnel, even briefly, in proper lifting form, before starting their jobs in the warehouse, can ensure safety, wellness, and productivity.

Beyond further training, performing certain exercises on a regular basis can reduce injuries and aches concomitant with warehouse work. Mooney, Kron, Rummerfield, and Holmes(1995) showed that engaging in lumbar extensor exercises once a week for 20 weeks resulted in reduced claims for lower back worker's compensation among the participants that received the training In fact, the participants who exercised their lumbar extensor doubled their back strength after the 20-week training period. The participants who engaged in lumbar extensor exercises had half as many lower back injuries per employee hour as the industry average and only 20% of the lower back injury rate of their cohorts in the same workspace. This is one example of how preparation on the part of the warehouse worker can dramatically reduce the rate of injury in warehouse work.

The findings direct attention to two very simple solutions that can potentially alleviate and prevent these health concerns. One is to teach these workers good lifting form; the other is to encourage workers to stretch before carrying out their duties. Using pallets also can help to reduce body part discomfort. Managers can do much more to reduce or prevent muscle and joint discomfort among their staff, but the aforementioned

techniques are simple and are easy to implement immediately. There is much more that managers can do to reduce and prevent muscle and joint discomfort among their staff, but the aforementioned techniques are simple and are simple to implement immediately.

Implications for Social Change

This study has implications for social change concerning work safety administration and guidelines. Warehouse workers must follow the regulations specified by the Occupational Safety and Health Administration (OSHA) which was established in the Occupational Safety & Health Act of 1970 OSHA, n.d.). The OSHA established a number of regulations that warehouses must observe. There are penalties for noncompliance with these regulations, as determined during OSHA inspections. These strict guidelines are changing the way warehouses operate. The following OSHA standards are especially relevant to warehouse operation: exits, mechanical power transmission, respiratory protection, lockout/tagout, portable fire extinguishers, hazard communication, forklifts, electrical wiring methods, electrical system design, and floor/wall openings. Warehouse operators must observe a number of OSHA guidelines or else risk having to pay the substantial fines levied during OSHA inspections.

One of the most frequent source of OSHA citations in warehouses concerns forklift operation. OSHA regulations impose limitations on the maximum speed of a forklift in a warehouse, clearance of aisles where forklifts pass, and certification of forklift operators. Chemical storage and spillage is another area of concern for OSHA regulations. These regulations on hazard communications specify that warehouse workers receive training in the control and cleanup of chemical spills and biohazard materials.

Another set of OSHA guidelines concerns lockout/tagout, whereby equipment that is not working or that poses a danger to other people needs to be tagged accordingly and should be locked out so that personnel who are unaware also are unable to use the equipment and put themselves in danger. Specific guidelines concern the words used in the tag, the accessibility of the tag, and the duration of tag. Portable fire extinguishers also need to be available to fight incipient fires; alternatively, employers should provide employees with information on an evacuation plan in case of fire.

Another set of OSHA guidelines concerns respiratory protection for warehouse workers. Well-ventilated warehouses prevent the inhalation of dust, paint, and noxious fumes in general. For this reason, OSHA-compliant warehouses typically invest in respirators that are regularly cleaned and maintained. One more set of OSHA guidelines concerns fall hazards. Openings in floors and walls must have guarding that prevents warehouse workers from accidentally falling. Falls can cause serious injury and even death. Lastly, there is other OSHA guidelines specify the level of ergonomic training and rest periods that warehouse workers should receive on the job. These are some of the OSHA regulations that require due diligence on the part of the employer as well as the warehouse workers themselves.

To facilitate greater OSHA compliance among employers who operate warehouses, the International Warehouse Logistics Association (2009) formed a partnership with OSHA to make training and education for OSHA guidelines more accessible to warehouse workers and provide checklists that make it easier to locate and address problem areas. A number of organizations have capitalized on the necessity for

OSHA compliance by providing critical information and training services to prepare warehouse workers and their employers for OSHA inspection.

An implication here is that part of the onus of preventing bodily discomfort because of warehouse labor also falls upon the employers of warehouse workers. These employers are responsible for setting the standards and guidelines in line with OSHA regulations that ultimately prevent debilitating bodily discomfort because of the labors of warehouse workers. By providing warehouse workers with general ergonomic and preparatory training for their general responsibilities and contingency training for specific events that can arise in the warehouse workspace, employers are able to ensure the health and well-being of their warehouse workers. For the most part, employers who maintain OSHA-compliant warehouses have already taken strides to reduce injury and bodily discomfort among their warehouse workers.

These findings posed a number of implications regarding the accountability of warehouse workers. Employers are responsible for providing warehouse workers with sufficient training, maintaining equipment, and ensuring that working conditions and equipment are in line with industry standards and OSHA specifications. Employers are culpable for any insufficiencies in these aspects that lead to bodily discomfort or injury. Beyond these aspects, responsibility and accountability lie with the individual warehouse workers. They must follow the guidelines stipulated by the OSHA and their employers to prevent injury and bodily discomfort. For instance, holding an employer accountable for a warehouse worker fracturing an ankle upon jumping from a loading dock, despite explicit instruction from the employer not to do so, is not reasonable. Holding warehouse

workers accountable for their injuries when they knowingly disregard the guidelines established by the OSHA and their employers is reasonable. Forklift drivers who do not wear their seatbelts, despite explicit instructions, expose themselves to personal injury at their own risk. Once employers have fulfilled their responsibilities to warehouse workers by staying OSHA-compliant, warehouse workers themselves are responsible and culpable for their own bodily discomfort resulting from their work.

Summary

This study was an investigation of group differences in body part discomfort among warehouse personnel. A questionnaire administered to 71 warehouse personnel assessed which body parts experienced discomfort in the previous week, how intense the discomfort was for each body part, and whether the discomfort in that body part contributed to interference in work. Measured were certain demographic variables and work variables, including shift, task performed, ethnicity, and others. The findings showed that discomfort among the participants was the most prevalent in the upper back, lower back, knees, and lower legs. Bending to lift objects more frequently was associated with higher levels of discomfort in the lower back, shoulders, and lower legs. The use of pallets generally led to reduced discomfort and resulting work interference in the hip/buttock, upper arm, and knees. There also were differences across shift and ethnicity. A finding that appeared recurrently across the data was the number of incidents of bad lifting form. These findings underscored the importance of proper training in lifting form and stretching to prevent injury and discomfort.

Health and well-being among warehouse personnel should be of great concern to their employers. The findings consistently showed that body part discomfort redounds to more interference with work. Unhealthy workers who have discomfort in various muscles and joints are less productive and less efficient than their healthier counterparts are. These findings can be useful to the practitioners of industrial health, but they are even more useful to the managers of warehouse staff. Unproductive warehouse workers who have WRSMDs can hinder the shipping and distribution processes of an organization.

Compliance with OSHA (n.d.) rules and regulations serves as the minimum requirements that employers must observe in an effort to foster good physical health among their warehouse workers. A relatively light investment in the treatment and prevention of WRSMDs among warehouse personnel can help to secure the place of an organization in industry because healthy and happy personnel are the backbone of a robust and efficient workforce.

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APPENDIX A: DEMOGRAPHICS QUESTIONNAIRE

Please write your name on the tape below. Names on the surveys will be removed upon submission to the researcher, who will provide codes to match patient assignment schedules and surveys. Subject confidentiality will be maintained during data analysis and reporting.

NAME: **(On removable tape) _____ Date:_____**

DEMOGRAPHICS QUESTIONNAIRE

Instructions: Please answer each question.

1. What is your age?_____ years
2. What is your gender? ☐ female ☐ male
3. What is your job category? ☐ warehouse worker ☐ forklift driver ☐ stock room clerk

4. Name of department in which you are currently assigned
   _____
5. Are you currently on modified or light duty ☐ Yes ☐ No
6. Do you wear supporting back brace on your job? ☐ Yes ☐ No
7. What shift do you work?

☐ Rotating Days/Evenings ☐ Rotating Days/Nights ☐ Permanent Evenings ☐ Permanent Nights

8. On a scale of 1 to 5 (below), how often do you use pallets handling and movement equipment, such as lifts, sliding boards, etc.?

1	2	3	4	5
Never		Sometimes		Always

9. On a scale of 1 to 5 (below), how often does another team member help you handle and move equipment/boxes etc?

1	2	3	4	5
Never		Sometimes		Always

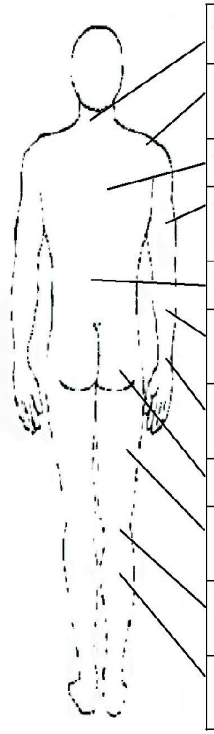
Please complete and return this and the attached Musculoskeletal Discomfort Questionnaire. Thank you.

Terrance N. Knox
540 Saint James Court
Lawrenceville, Georgia 30044

APPENDIX B: CDMQ

Appendix C: Cornell Musculoskeletal Discomfort Questionnaire, Male

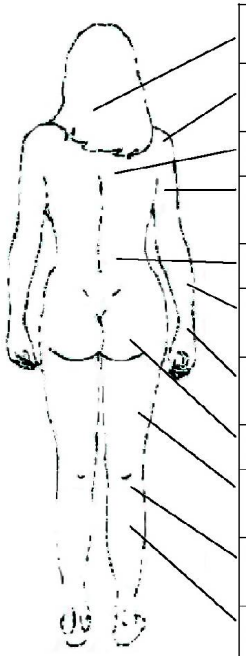
The diagram below shows the approximate position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.



		During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with your ability to work?		
		Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly uncomfortable	Moderately uncomfortable	Very uncomfortable	Not at all	Slightly interfered	Substantially interfered
Neck		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Arm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forearm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wrist	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hip/Buttocks		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thigh	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knee	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Leg	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Appendix B: Cornell Musculoskeletal Discomfort Questionnaire, Female

The diagram below shows the approximate position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.



		During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with your ability to work?		
		Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly uncomfortable	Moderately uncomfortable	Very uncomfortable	Not at all	Slightly interfered	Substantially interfered
Neck		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Arm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forearm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wrist	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hip/Buttocks		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thigh	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knee	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Leg	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

APPENDIX C: RECRUITMENT POSTER

RESEARCH PARTICIPANTS WANTED

- If you are a warehouse worker, a stockroom clerk, or a forklift operator.
- If you are at least 18 years old.

Please call Terrance Knox at (404) 401-7386 for more information.

APPENDIX D: INFORMED CONSENT

You are invited to take part in a research study of Manual Handling Workload Among Warehouse Personnel. You are being asked to participate because you are involved in manual handling task at your workplace that might put you at risk of developing a work-related musculoskeletal disorder such as back pain. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Terrance Knox who is a doctoral student at Walden University.

Background Information:

The purpose of this study is to analyze whether the manual handling workload of warehouse personnel is associated with the prevalence of symptoms of work- related musculoskeletal orders and whether the manual handling workload differs among warehouse personnel.

Procedures:

If you agree to be in this study, you will be asked to:

- Complete the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), the duration of this study will consist of seven (7) work days.
- Complete a demographic questionnaire.
- Complete a at risk task survey.

Voluntary Nature of the Study

Your participation in this study is voluntary. This means that everyone will respect your decision of whether or not to be in the study. If you decide to join the study now, you can

still change your mind during the study. If you feel stressed during the study you may stop at any time. You may skip questions that you feel are too personal.

Risks and benefits of being in the study.

There are no known risks to completing the surveys. There may be some future benefit to you by reducing your risk of musculoskeletal injury

Compensation

There is no compensation for participating in this study.

Confidentiality of Your Records

Your privacy and research records will be kept confidential. The researcher will not use your information for any purposes outside of this research project. In addition, the researcher will not include your name or anything else that could identify you in any reports of the study.

Questions and Contracts

You may ask any questions you have now, or if you have questions later, you may contact the researcher via phone 404-401-7386, or by email tknox001@waldenu.edu. If you want to talk privately about your rights as a participant, you can call Dr.Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 1-800-925-3368, extension 1210.

Printed Name of Participant _____

Date of consent _____

Participant's Written or Electronic Signature _____

Researcher's Written or Electronic Signature _____

Electronic signatures are regulated by the Uniform Electronic Transactions Act. "electronic signature" can be the person's typed name, their email address or any identifying marker. An electronic signature is just as valid as a written signature as long as both parties have agreed to conduct the transaction electronically.

This has been approved by the Institutional Review Board of WALDEN UNIVERSITY as acceptable documentation of the informed consent process and is valid for one year after the stamped date.

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APPENDIX E: AT-RISK TASKS

Date		
Warehouse personnel	Warehouse worker , fork lift driver, and stockroom clerk	
Shift:		Hours worked?

Class, Rating	Weight	Freq.	Task
			Lifting boxes
			Transferring pallets from one location to another
			Lifting objects from an awkward position
			Pushing or pulling objects
			Bending to pick up an object or objects
			Performing repetitive tasks
			Lifting objects over the head
			Transferring equipment without the use of lifting equipment
			Standing for a long period of time
			Sitting in one position for an extended period of time

CURRICULUM VITAE

TERRANCE N. KNOX

SUMMARY OF QUALIFICATIONS

- ***Certified Professional*** with extensive experience in Full Life Cycle Deployment, Risk Management, Engineering, and Quality Control for large-scale projects.
- ***Supervised*** team of 20 technicians that installed an expanded communications network for 5,000+ clients, completing the project under budget by 7%.
- ***Innovative*** leader committed to delivering projects within defined scope, time, and cost.
- ***Key contributor*** for redesigning and streamlining project management process in terms of project initiation, prioritization and feasibility requirements.
- ***Served*** as trainer through Dale Carnegie for 30+ participants and the Toastmaster International Club. Active member of Toastmasters International.
- ***Proficient*** in MS Office, Windows 98, 2000, 2003, XP, Crystal. Blackboard, OLS, ECollege, and WebCT.

EDUCATION, CERTIFICATIONS AND AFFILIATIONS

- ***PhD Applied Decision Science Management***, Walden University Minneapolis, MN
  Specialization in Engineering Management Anticipated Date of Graduation: 03/2010
- ***Master of Business Administration***, American InterContinental University, Atlanta, GA
- ***Bachelor of Science***, Technical Management, DeVry Institute of Technology, Atlanta, GA
- ***Project Management***, Villanova University, Villanova, PA
- ***Dale Carnegie Course***, Atlanta, GA
- ***Engineering Technology***, Nielsen Electronics Institute, Charleston, SC
- ***CompTIA Project+ Certification***, Atlanta, GA
- ***UMTS Installation Certification***, EXI Parson Inc., Richardson, TX

PROFESSIONAL EXPERIENCE

2006 – Present ***Professor,*** University of Phoenix, Atlanta, GA

- Prepare course materials for Statistics and Business Management studies.
- Implement student performance guidelines and track progress.
- Facilitate undergrad programs via classroom and online instruction.

2006 – 2008 ***Project Coordinator,*** Verizon Wireless, Atlanta, GA

- Served as project lead for multi-million dollar business, handling project planning, deployment lifecycle and the enterprise-wide security software upgrade for approximately 10,000 end users.
- Addressed developers and project stakeholders at kick-off meeting. Outlined and introduced project, team members' roles, key deliverables, and communication processes.
- Implemented consulting vendor management program to manage site coordination, negotiations, contract administration, and invoicing.
- Key contributor in upgrading Verizon's project management process.
- Performed business analysis to assess project initiation and execution against business growth strategy and designed Statement of Work.
- Created detailed diagrams and activity guides for workflow, IT methodology, engagements, standards, resources, scope, risk, timelines and customer expectations.

2005 – 2006 ***Project Manager,*** Sprint/Nextel, Atlanta, GA

- Directed team of 20 technicians in upgrading 2,000 network systems to increase business continuity for remote offices and in-house users.
- Oversaw full life-cycle deployment for assigned projects and served as key facilitator in producing the company's distributed technology standards.
- Deployed Microsoft Project and Gantt Charts to manage deliverables, resources and produce weekly reports.
- Performed QA testing, defined repair process, developed cost analysis and ROI to ensure product relevancy and cost efficiency.
- Evaluated formalized processes for end user requests and offered recommendations on improving results.
- Developed core positioning and messaging for assigned projects.
- Served as French language and culture instructor for college students and implemented guidelines for student participation.

2004 – 2005 ***Sr. Field Engineer,*** EMS Technologies, Atlanta, GA

- Supervised 12 technicians for installation of voice and unified communication network and provided PC/LAN support for 75 employees.
- Performed diagnostics and maintenance on Cisco systems, CDMA, GSM, TDMA and iDEN technologies as well as handling upkeep (patches, backups, configuration, storage, and device monitoring and event log management) for network and telecommunications devices.
- Helped in strategic planning of the company's distributed technology standards.
- Established processes for managing end-user requests, purchasing and approval.

2002 – 2004 ***Project Engineer,*** EP&S/Cingular Wireless, Atlanta, GA

- Developed communication strategies between IT and functional business units while managing the Enterprise Solutions Program Management Office.
- Effectively reorganized consulting vendor management program to streamline contract negotiations and administration, invoice processing and site coordination.
- Conducted cost analysis, reviewed business requirements and monitored deliverables against business unit expectations.
- Coordinated sales group and technicians in creating marketing displays in a major retail store.

2000 – 2002 ***Sr. Field Service Engineer,*** Tellabs Operations, Atlanta, GA

- Oversaw team of 20 technicians for installation of an expanded communications network supporting 5,000+ customers.
- Handled troubleshooting and testing of Cisco routers, installation and configuration of network connections and prepared business requirements.
- Worked with key functional areas to deliver project updates to senior management and key stakeholders.
- Served as project lead for system architecture, maintaining diagnostics, functionality, and TL1 language of the TITAN500/S.