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**Musculoskeletal Injuries Associated with
Selected University Staff and Faculty
in an Office Environment**

prepared for
National Institute of Occupational Safety and Health (NIOSH)
Under Grant No. T421/CCT51040
University of Cincinnati Education and Research Center
Cincinnati, OH

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Background of the Problem

Office workers have been identified as having high levels of job discomfort. This may be caused by the arrangement of the office space. Awkward postures are at times necessary to perform job duties due to the arrangement of furniture, computer(s), and supplies. Workstation layout and working conditions (lighting, posture, activities) contribute to risks leading to injury. Discomforts can exacerbate into symptoms of work-related musculoskeletal disorders (WRMDs) of the upper extremities, the most common being carpal tunnel syndrome.

The United States Bureau of Labor Statistics (BLS) reports the prevalence of musculoskeletal injuries in private industry. In 1994, the BLS reported 92,576 repetitive trauma cases associated with typing or data entry; 55 percent of these injuries affected the wrist, 7 percent affected the shoulder, and 6 percent affected the back (NIOSH, 2002). Although there is a low number of WRMDs related to office tasks, worker discomfort is very common (Bettendorf, 1999).

Additionally, complaints from office workers are often related to difficulty in attaining clear vision. A majority of vision-related complaints were due to the work area being too bright, thus making computer monitors difficult to view. Glare on the screen frequently causes the worker to strain when looking at the monitor.

Purpose of the Study

To examine the occurrence of WRMDs in a university setting, faculty at Eastern Kentucky University (EKU) applied for a grant to study the phenomenon. The application was received, funded and supported by the National Institute of Occupational Safety & Health (NIOSH) and the University of Cincinnati Education and Research Center (ERC) under the Pilot Project Research Training Program. The study was designed to apply a questionnaire that participants completed describing aspects of their work with an observational assessment (performed by a graduate assistant) of participants at their workstation. Observations were made to identify potential physical risk factors that are related to WRMDs and compare those risk factors identified to those identified in the literature. The research team's objective was to validate, or qualify, the risk factors found in the literature. Since both environmental health science practitioners and occupational therapists believe that preventive measures can often be cost-effective and efficiently applied in practice, the researchers then assessed the data to recommend means to eliminate or mitigate the risk. The research team also collected workers compensation data to better understand the injuries of the targeted group (selected university and staff workers) compared to university workers as a whole. The costs associated with WRMDs were not available. The team wanted to determine, for instance, if clerical/secretarial office workers experienced injuries at a far greater rate than university professors; they did, by a ratio slightly greater than 1.4:1. However Physical Plant workers may experience accident rates many times higher than those of faculty and clerical/secretarial employees combined.

Procedure

The proposal for this research study was submitted to the Human Subjects Committee in the College of Health Sciences, Eastern Kentucky University (EKU), Richmond, Kentucky for approval. This committee approved the study as “No Risk” on February 25, 2002 (See Appendix A). This approval took approximately six weeks.

The team of investigators for this study explored existing office ergonomic assessments as well as considered the development of a new instrument. After consultation with Professor Karen Jacobs Ed.D, OTR/L, CPE, from Boston University, the research team decided to use either the NIOSH Survey Software or the Army Software. After reviewing both, it was felt that the Army Instrument had several advantages: (a) there would be less possibility of errors in collecting the data because there were more specific items on the instrument, (b) the instrument was compatible with the risk factors identified in the literature, and (c) there were more items on the instrument, thus providing additional data for this study and future studies.

A request for participation in the study was sent out by Dr. David Gale, Dean of the College of Health Sciences, EKU, on March 14, 2002 to all faculty and staff in the College. Attached to the request for participation was the Informed Consent (See Appendix B). Individuals were asked to send their completed Informed Consent forms to Dr. Gale’s office. These informed consent forms were maintained in a locked file for confidentiality.

The observational assessment, Army Instrument, was piloted at five workstations to assure consistency in data collected by each of the two graduate assistants, and to determine the

procedure for the rest of the study. In addition to the Army Instrument, a questionnaire was developed by the team of investigators (See Appendix C). It was decided these questionnaires would be coded to comply with the Army instrument of each individual, in order to allow for inclusion of demographic information for each participant, as well as the observational ergonomic data. This data collection began as scheduled on April 15, 2002 for approximately 20 participants.

In-person follow-up by project investigators and the Dean's administrative assistant yielded the balance of 30 additional participants. The team concluded participation was greatly enhanced by explaining to individuals one on one the purpose of the study.

Literature Review

A review of the literature was performed using a variety of sources including academic texts in the field of ergonomics and physical dysfunction, the search engine PubMed, and various other government agency documents and web pages. The literature search was conducted in order to find the published risk factors, incidence rates, and costs involved with WRMDs. According to the Occupational Safety and Health Administration (OSHA), more than 2,000 articles on work-related WRMDs and workplace risk factors exist (OSHA, 1999b). Avoiding exposure to risk factors is identified as a common sense strategy for eliminating unnecessary musculoskeletal disorders.

Of the 125 million days lost because of work injuries and illnesses (this includes fatalities) 80 million days were lost to injuries alone. A total of 372,300 occupational illnesses were reported in 1999. Disorders of repetitive trauma were the most common, skin diseases second, and respiratory trauma from chemical toxicity third. (National Safety Council, 2001).

Carpal tunnel syndrome (CTS) was examined in the injury/illness category since it is one of the prevalent WRMDs for office workers. The highest incidence of CTS is in manufacturing; it is also significant in services, wholesale and retail trade, and transportation and public utilities.

The BLS reported 705,800 workers missing work due to fatigue or repetitive motion (BLS, 1995). The NIOSH (1996) and AFL-CIO (1997) report WRMDs -- such as CTS -- accounted for \$13 to \$20 billion annually in compensation claims. These figures suggest it is not a simple matter to classify and account for the costs of WRMDs. Psychological factors, organizational factors, work procedures, equipment, and work environment were other factors that affected WRMDs. Therefore, the source and character of WRMDs needed clarifying, especially with respect to soft tissue injuries.

Throughout the day, soft tissue transformation differs depending on many variables (fatigue, work pattern, and co-activation of muscles). Damage occurs when the pressure exerted on muscles and surrounding tissue exceeds the ability of the tissue to withstand the load. The damage is in the form of inflammation, edema, and biochemical responses, or, if severe enough, the damage can result in nerve compression, tears, or dislocation (Dahl, 2000).

Symptomatic and asymptomatic reactions can occur from biomechanical loading. Biomechanical loading may affect the way individuals perform certain tasks or use certain muscle groups. For example, wrist angle pain could have caused a subject to load muscles differently or to avoid use of certain muscle groups, which produces a different loading pattern or uses an alternate set of muscles. Either way, adaptation to this different pattern could cause a chain of events resulting in overloading, overuse, and severe damage.

Risk Factors

Environmental factors (work procedures, equipment, environment, organizational factors, etc.) affect the development of WRMDs. Time pressure to meet a production quota was an example of an organizational factor. Time pressure affects the biomechanical loading when the employee in haste was careless, used improper body mechanics, and loaded tissues in a manner leading to injury. There is a substantial body of credible epidemiological research, which provides strong evidence of a relationship between WRMDs and certain work-related risk factors. When there are high levels of exposure, especially in combination with more than one physical risk factor (such as awkward posture, repetitive motion, force and vibration) symptoms of WRMDs may emerge (NIOSH, 2002). The National Research Council used the following five criteria to determine the relationship between factors:

1. soft tissue responses to physical stressors (load and response)
2. work factors and biomechanics (load-response relationship; and procedures, equipment, and environment)
3. epidemiological evidence relating biomechanical factors to WRMDs
4. state of the evidence regarding contributions of non-biomechanical factors (organizational, social, and individual)
5. workplace interventions (National Research Council, 2001)

Work Factors and Biomechanics

Some tissues, (i.e. muscle) are able to adapt to repetitive loading up to a certain point; while the ability of other tissues (i.e. nerve tissue) to adapt is greatly reduced. Exertion, posture, contact stress, vibration, and varying temperatures are external stressors. In work situations, bodies are positioned and exerted to accomplish a task, which results in stress.

Force required to support an object is related to weight and friction. Forces required to depress the keys on a keyboard are related to stiffness of the keys. However, there are significant variations from person to person. Unfortunately, frequency and duration of exertions are often related to work standards and quotas. Pay incentives, while encouraging faster work, usually result in insufficient recovery time for muscles. Recreational activities and daily living can produce external stresses; however, the duration of exposures does not equal the 40+ hours per week that normally occurs in work settings. Fatigue appreciably affects worker comfort and lowers work accomplishment; it is a passing response that dissolves rapidly when work is stopped. In some cases, loads are large enough or last long enough to arouse acute tissue disorders. A healing response occurs when tissue is damaged, but if the load continues to be applied, healing cannot take place.

According to the American National Standards Institute (ANSI), job attributes can increase WRMD probability (ANSI, 1995). Job attributes focus on the mechanics of jobs and the environment.

NIOSH reviewed 2,000 studies, and concluded that credible evidence exists showing a relationship between certain physical factors and WRMDs. According to NIOSH, the risk factors

associated with WRMDs include repetitive, forceful or prolonged exertions of the hands; frequent or heavy lifting, pushing, pulling, or carrying of heavy objects; prolonged awkward postures; and vibration (NIOSH, 1997). The level of risk depends on duration, frequency and level of exposure. Personal risk factors include stress, age, gender, psychosocial, and cognitive factors; along with biomechanics of work tasks, organizational structures, and work environmental factors. OSHA has identified force, mechanical stress, repetition, awkward posture, static posture, vibration and cold temperature as risk factors for WRMDs (OSHA, 1999a). Experts at Cornell University stated that multiple users of the same unadjustable computer workstation result in a “sub optimal” workstation for all users (Cornell Human Factors Group, 1996).

Martin et.al. (1999) stated that workstations must be adjustable in order to maintain neutral postures and that an ergonomically correct workstation is related to an increase in production, comfort, and an increase in employee morale. Computer use can increase carpal pressure through wrist extension and/or wrist flexion. An increase in carpal pressure will prevent the inflow and outflow of fluids and impair median nerve function. Several studies show the range of pressure at the carpal tunnel to be safe with sustained posture below 40 mmHg, which translates into 30° of flexion and 15° of extension (Hedge et. al., 1999). A standard keyboard on a desk puts the wrist in > 20° of extension in most users. In order for a keyboard to offer a neutral typing posture it must have a negative slope (Martin et. al., 1999, Hedge et. al., 1999). Hedge et. al., (1999) tested office workers and found those using a downward sloping keyboard tray experienced significant improvements in all body postures, and a decrease in stress in the upper back and neck.

Cornell researchers identified incorrect levels of lighting, temperature, noise, ventilation, electrostatic electricity, and exposure to vibration as risk factors for WRMDs (Cornell Human Factors Group, 1996). Dahl (2000) linked musculoskeletal loading, awkward postures, forceful exertions (lift, carry, push, pull), repetitive motion, duration, task invariability, mechanical stress, vibration, extreme temperatures, sustained exertions, and sustained stretching to WRMDs. Martin et. al., (1999) suggest the neutral position for the elbows, hips, and knees is 90° while neutral for the wrists is straight, i.e., not flexed or extended, and the natural curves of the back should be supported by a well-designed chair (Martin, 1999). Mechanical stress occurs when a body part makes contact with a hard or sharp object such as a table, keyboard or tool. Parts of the body are particularly susceptible to mechanical pressure secondary to their location. For example, those who must type most of their workday are particularly likely to have more mechanical stress on their wrists (Dahl, 2000).

Chairs should be manufactured to allow three positions, (90° at the hip, 90° at the knee, and 90° at the ankle; forward tilt; and Grandjean or reclining position) (Martin et. al., 1999). These positions vary muscle loading while maintaining support at all crucial points. As chair height changes, the workstation must change in order to maintain a neutral position. The high repetition and sustained awkward postures at the computer and during administrative work decrease blood flow to the neck, shoulders, arms, and back; these also increase stress. During the process of high repetition and sustained awkward postures, a buildup of waste products and intramuscular pressure results in pain and inflammation, which leads to nerve compression (Dahl, 2000; National

Safety Council, 1994; Tadano, 1990). Dahl also states that muscles stretched in a sustained manner undergo a physiological change of sarcomere production leading to a further imbalance with the possibility of leading to nerve compression. He states fatigue is an important factor in office ergonomics because of the effect on performance (Dahl, 2000). There are three types of fatigue: 1) subjective fatigue B decreasing motivation and alertness, 2) objective fatigue B measurable decrease in productivity, and 3) physiological fatigue B changes in the physiology of the worker.

Since the dawn of the information age, computer use has increased dramatically, resulting in the development of new jobs such as data processing. In addition, computerization of the administrative portion of jobs is widespread and apparently increasing. While performing administrative and computer tasks the muscles of the neck and shoulders perform static contractions while the smaller hand and forearm muscles are constantly dynamically contracting. Depending on the structure of work and the economy, workers may be spending more time than ever before at their workstations.

Relatively sedentary occupations such as an office secretary, or faculty member, include sustained postures for reading, performing computer tasks, telephone work, and the tedious task of paper grading. These sustained postures and muscle contractions cause prolonged tension in muscle groups that leads to strain (Dahl, 2000). Frequency of muscle contraction and duration are important in recovery of blood flow and avoiding WRMDs. Repeated external compression is a common contributor to peripheral nerve injuries (Tadano, 1990). Two of the most common pressure points of the upper extremity are the ulnar nerve at the elbow and the median nerve at the wrist, sites of many injuries. CTS results from excessive compression of the median nerve.

University Industry-Specific Profile

The Government Accounting Office (GAO) performed a literature review and interviewed experts in the business, labor, and academic communities with expertise in ergonomics. The core elements of an effective ergonomics program were determined to be:

- Management commitment
- Employee involvement
- Identification of problem jobs
- Development of solutions/controls for problem jobs
- Training and education for employees
- Appropriate medical management

The GAO conducted case studies using five private-sector organizations. The organization that most closely correlated to the university environment was American Express Financial Advisors, Inc. (AEFA). AEFA employed approximately 8,000 nonunion employees in 250 locations throughout the country. The majority of the employees worked in an office environment using computers. Many of the employees worked in the Client Service Organization (CSO), a phone-and computer-intensive environment. AEFA did not have a formal written ergonomic program. The ergonomic staff identified problem jobs, conducted workstation evaluations, developed controls, provided employee training, and kept files on what training and services had been provided to employees. Employees reported they knew whom to call, that response was quick, and often changes were made. Office ergonomics training was strongly encouraged by the ergonomic staff. Whenever an employee reported a problem, a workstation adjustment/evaluation

and training were required. Employees were provided information on correct ergonomics, how to maintain comfort while working on computers, and were measured (recorded for future use) for workstation setup. Then they were given an anonymous survey to report body part discomfort and to what extent that was experienced. They were also asked to give feedback on the quality of training and if they expected the training to affect their work.

Ergonomic management and medical management worked together to ensure early reporting and expedient evaluation of injuries. AEFA provided the local health care providers with expertise in diagnosing WRMDs. These health care providers were encouraged to visit the work environment so they would have a better knowledge base to analyze, diagnose, and prescribe. AEFA used restricted-and light-duty assignments when employees returned to work after injury. Employees who could no longer perform their duties were assisted in finding another job within AEFA if possible.

Two of the most common pressure areas of the upper extremities are the ulnar nerve at the elbow and the median nerve at the wrist, sites of cubital tunnel syndrome (ulnar nerve) and CTS (median nerve). Guidelines for the sitting posture at a computer workstation have been widely published. These include feet flat on the floor, knees even or just below the hips, lumbar support, elbows at 90° - 105°, shoulders relaxed, and wrists in a neutral or slightly extended position. Techniques in keying and mechanical stress have been shown to contribute to nerve injuries. Since the keyboard is certainly one of the prime pieces of equipment used, it is important that the correct relationship be established (Tadano, 1990). Eye conditions associated with WRMDs, such as

strain, fatigue, blurred vision, headaches, and dizziness, are common and can lead to poor posture as computer users attempt to compensate, knowingly or not, for visual problems (OSHA, 1986; Tadano, 1990).

Incidence Rates

WRMDs affect 7 percent of the population and account for 14 percent of physician visits and 19 percent of hospital stays (NIOSH, 1997). In 1995, the BLS reported 62 percent of all illness/injury cases were WRMDs associated with repetitive motion. The BLS also reported that WRMDs were responsible for 32 percent of cases involving days away from work (NIOSH, 1997). The 1994 BLS Annual Survey of Occupational Injuries and Illnesses reported 705,800 cases were the result of repetitive motion or overexertion. Of these injuries or illnesses, 92,576 were specifically due to repetitive motion, including typing and keyboard entry, repetitive use of tools, and repetitive movement of objects. As noted earlier 55 percent of these injuries reported affected the wrist (Bernard, Bruce, Ed., 1997).

After reviewing 600 articles, Putz-Anderson (See Bernard, Bruce, Ed., 1997) found credible research supporting an association between WRMDs and certain work-related physical factors when there are high levels of exposure and especially when individuals were exposed to multiple risk factors (1997). The strongest evidence was associated with daily whole exposure during the entire shift of work (Bernard, Bruce, Ed., 1997). According to the BLS, in 1997 64 percent of occupational illnesses were new cases of WRMDs (National Safety Council, 1999). In 1996 and 1997, the average of workers' compensation insurance claim costs was approximately \$10,500 and

\$12,600 respectively for CTS (National Safety Council, 1999). According to OSHA, WRMDs account for 33 percent of all work injuries each year. No other category is larger. Subsequently, WRMDs are the biggest cost burden for employers, accounting for one out of every three dollars spent for worker's compensation and totaling \$15-\$20 billion per year with another \$25-\$30 billion in associated costs (OSHA, 1999b).

An analysis of incidents at ECU from 1994-2001 shows that there has been 26 injuries which may qualify as WRMDs. The specific incidents, and the year that they occurred, are shown in Appendix D. The source of this data is OSHA logs.

OSHA has scientifically established the relationship between work and the development of WRMDs (OSHA, 1999a, OSHA, 1999b). Thus a well-developed ergonomics program along the lines of management guidelines provided in the GAO can save institutions like universities substantial sums of money through prevention measures. Recommendations for an ECU program are included as Appendix E.

Tiraloschi, et al. (2002), found that employees report a significant decrease in the level of pain and discomfort after an Office Ergonomics Program Assessment. Efforts to evaluate a program's effectiveness plays a critical role in measuring how successful interventions are in reducing the prevalence of work-related musculoskeletal disorders in the workplace.

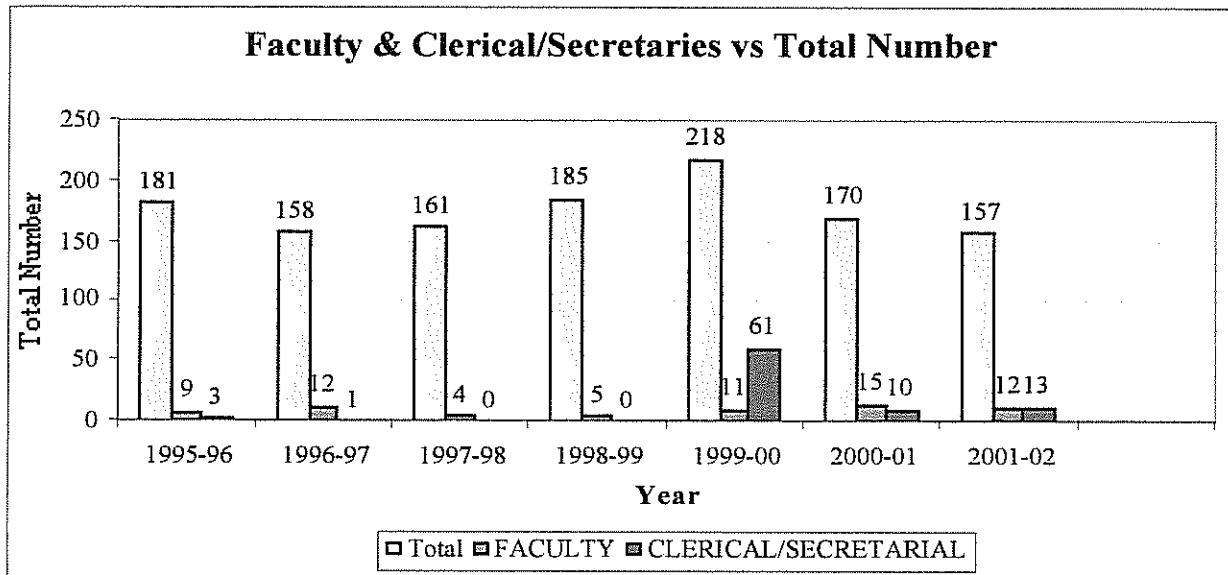
Workers' Compensation

The BLS compiled data for colleges and universities indicating 5,695 nonfatal injuries occurred in 2000 (DoL, 2002). Of this total, 183 were due to repetitive motion (3 percent) and 812 were due to lifting (14 percent). The most prevalent occurrence, 1042, was due to falling on the same level (18 percent).

EKU compiles accident data for faculty, students, and staff. Figure 1 shows the total number of injuries per year from Academic Years 1995 to 2002 comparing faculty and clerical/secretarial staff.

Figure 1
Eastern Kentucky University Occupational Injuries,
Academic Years 1995-2002

Total Accidents, and Number of Accidents Involving Faculty and Clerical/Secretarial Personnel



The "Staff" category includes everyone at the University beside faculty and the students.

EKU's Environmental Safety and Health / Workers' Compensation Office categorizes the incidents in the following departments:

- Arlington Mansion, a separate University property
- Student Life
- Clerical/Secretarial
- Faculty
- Food Services
- Physical Plant, also known as Facility Services
- Public Safety
- University Farms, and
- Other (students)

As of June 30, 2002 (AY 2001-02), approximately 8 percent of the incidents were classified as involving Faculty, whereas another 8 percent were classified as involving clerical/secretarial staff. The physical plant accounted for over 60 percent, a major contributor to the overall accident rate.

EKU data indicates similar trends to BLS data with incidents involving lifting (16 percent) and falls (18.5 percent) significant areas of concern. This is about one-third of the occupational injuries in university settings. Repetitive motion injuries have been recorded as a cause of injury at EKU for the past two years, as shown in Appendix D. Before that time, these injuries were not recorded as a separate category. The two-year database is too small to be useful for trend analysis to predict EKU repetitive motion injuries and for comparison with BLS data.

Table 1 Affected Body Parts and Causes of Injuries, shows that the hands are the most affected upper extremity body part in WRMDs. There were 137 hand injuries compared to 53 and 35 for arms and shoulder, respectively, in the 1995 – 2002 time frame. The University is now

tracking repetitive motion injuries (see Table 1). Table 1 also shows the causes of injuries by category.

Table 1 AFFECTED BODY PARTS AND CAUSES OF INJURIES, (By Year, at Eastern Kentucky University)						
DATE	UPPER EXTREMITIES (related to WRMDs)			CAUSES OF INJURIES, BY MAJOR CATEGORY		
YEAR	ARMS	HANDS	SHOULDER	FALLS	LIFTING	REPETITIVE MOTION
1995-96	14	19	4	36	32	
1996-97	6	16	3	33	26	
1997-98	9	22	7	21	30	
1998-99	14	16	9	32	34	
1999-00	10	21	7	38	37	
2000-01		14	4	33	28	7*
2001-02		29	1	35	12	3*
TOTALS	53	137	35	228	201	10
Note: *Repetitive Motion data collected only for the past two years.						

It is worth noting that by far the greatest number of incidents University-wide occurs to Staff, rather than Faculty or Students. For the previous seven academic years (beginning with AY 1995-1996), the total accidents involving Staff were: 162, 144, 146, 165, 206, 150 and finally 142 in AY 2001-02. The above graph and the data from this NIOSH study strongly suggests a need for explaining the underlying causes for the clerical/secretarial increase in Academic Year 1999-00; it also suggests an ergonomics program targeted at Staff rather than Faculty might have a more immediate and dramatic effect on the cost to the University. Although these areas are beyond the

scope of the present study, our data analysis and findings support the conclusion that all University employees may be able to make strides to reduce accidents and attendant costs of lost work days (as well as personal costs to individuals due to their injuries). Appendix D 'Faculty and Staff Occupational Accident Analysis, 1994 – 2001' lists the upper extremity WRMDs at the University. These are reproduced from the OSHA 200 logs. In addition to medical costs, the University must find resources to replace the lost work days (LWD). The LWD data in Appendix D show great variation in the LWDs, from none to more than missing an entire year of work.

Descriptive Data Associated with Ergonomic Assessment Participants

The data was obtained from 50 participants, comprised of 33 faculty and 17 staff members. Actual measurements were not taken at the workstations. The data collected was categorical, with a questionnaire asking the participants about the configuration of their workstation.

Of the 50 participants, 39 were female (approximately 80 percent). Nearly half the participants fall in the age group of 51-60 years. Fourteen participants were in the age group 31-40 years and thirteen in the 41-50 age group.

Weight distribution among the participants revealed a uniform pattern, with many of the participants (16) weighing between 131-160 lbs. There was a steady decline in numbers (5) towards the >220 lbs. range. There were 7 females and no males in the 101-130 lb. category. Most female participants were in the 131-160 lb. category; whereas, the 161-190 lbs. category included the maximum number (4) of male participants. The last three categories, spanning a weight range of 161- > 220 lbs. included 8 male participants (70 percent) and 16 female participants (45 percent).

Participants held either faculty or staff positions. Faculty were not identified by rank. However, Staff members were identified as either secretarial (13) or graduate assistants (3). One participant's position was not identified.

The overall distribution of work hours per week was fairly proportional between the three categories: 30-40 hours (19), 40-50 hours (14), or 50-60 hours (16). There was a significant difference between the number of work hours reported by faculty and staff. More than 80 percent of staff (14) worked 30-40 hours a week. However, 15 faculty members (45 percent) reported working more than 50 hours a week, 12 (35 percent) reported working 40-50 hours a week and five reported working 30-40 hours.

Eighteen participants (36 percent) reported working at the computer 30-60 minutes without interruption. Twelve participants (24 percent) reported working 1-2 hours without interruption. Similar to the number of hours reported worked, the average period of time at the computer without interruption for the faculty and staff also was different. Approximately 40 percent of the staff (5) reported working less than 30 minutes without interruption; whereas, 45 percent of the faculty (15) reported time at the computer of 30-60 minutes without interruption. In addition, nine faculty members (30 percent) reported 1-2 hours at the computer without interruption.

Data Analysis

The data was collected by two graduate assistants funded by the project grant.

Observations were made and data entered at the workstation of the participants, using palm pilots, and each participant was asked to complete a questionnaire (See Appendix C for the questions).

Using the 50 questionnaires and observational assessment, a Microsoft Access spreadsheet database was created. This data was categorical and the research questions were used to compare staff and faculty in terms of their exposure to risk factors relevant to work-related musculoskeletal disorders. The risk factors in the literature that were also identified in this study were awkward postures and mechanical stress.

The investigators with expertise in work-related musculoskeletal disorders examined items on the instrument used in the study to determine which items should be statistically manipulated to determine statistical significance. No measurements were taken at the workstations; therefore, items with specific measurements were not statistically examined. The instrument used for the study had the following items—these items were also identified in the literature as risk factors--which contribute to cumulative trauma due to their impact on awkward posture:

Keyboard - Section VI, Items 5 & 6
Monitor - Section V, Item 8
Chair - Section III, Items 5 & 22
Desk - Section II, Item 6

The instrument used for the study had the following items that were identified in the literature as risk factors contributing to cumulative trauma due to their impact on mechanical stress:

Keyboard - Section VI, Items 7 & 8
Chair - Section III, Items 8, 12, 13 & 16

The purpose of the study was to determine if there is a difference between staff workstations and faculty workstations in a college within a comprehensive regional university; therefore, the chi-square statistic was used. A chi-square was conducted to examine the relationship between participants (faculty and staff) and each of the above items. The items were responded to with either a yes or a no. The results revealed ten of the items were non-significant and two were marginally significant.

Specifically, the chi-square test was conducted to examine if a relationship existed between position (faculty and staff) and keyboard item #6 awkward posture (yes and no). The results reveal that there was a marginally significant relationship between these variables, $\chi^2(1) = 3.44$, $p > .07$. Graduate assistants observed that some of the Faculty keyboard positions were awkward, while others were not. By contrast, the graduate assistants found that keyboard positions were not awkward for Staff by a 2 to 1 ratio.

The other marginally significant relationship existed between position (Faculty, Staff) and keyboard item #8 mechanical stress (yes and no). The results reveal there was a marginally significant relationship between these variables, $\chi^2(1) = 3.13$, $p > .07$. Faculty were observed and the result was that for some of them the keyboard was causing mechanical stress, while for other Faculty this was not the case. However, for Staff, graduate assistants observed that the keyboard was mechanically stressful by a 2 to 1 ratio among the participants.

Findings and Conclusions

The results presented above elucidate the process involved in conducting applied research. They also demonstrate the effectiveness and outcomes of interdisciplinary collaborative research. However, there were limitations. These were:

1. The number of faculty and staff surveyed in the College of Health Sciences (50 of 208 current staff and faculty members), is a relatively small percentage of the total faculty and staff at the University (approximately 2,800).
2. Workers' compensation data for repetitive injuries was limited to two years; workers' compensation data was difficult to obtain (especially cost data). The research team recommends further analysis of this workers' compensation data at a later date.
3. The observational data collected at the workstation was collected at one point in time.
4. Logistical challenges such as faculty release time, IRB approval timeframes, computer platform transferability, and data transmission. The research team recommends tackling these challenges early in project design with sufficient resources.

The findings of this study support the description of risk factors which contribute to WRMDs found in the literature. Specifically, awkward postures, mechanical stress at the keyboard, and poor workstation design can be problematic. The first two risk factors were marginally statistically significant in this study. In addition, review of the workers'

compensation data suggests WRMDs can be particularly significant in terms of total injuries and costs to the University, considering lost workdays as part of the cost.

Future research in the area of WRMDs in university environments, such as at ECU, should be conducted with the Physical Plant or Facility Services management and employees, where the majority of injuries are being reported. There will always be some WRMDs in physically demanding jobs; however, vigilant implementation of the recommendations suggested in this study, can assist in preventing and managing these injuries (see Appendix E). Exploring the perceptions of workers and supervisors and enlisting their participation in an ECU ergonomics program has the potential to provide an additional dimension to preventing WRMDs. Our preliminary research indicates that preventing WRMDs in Facility Services would complement design of a new program to reduce WRMDs at workstations. Certainly additional research in this arena is warranted and could save the University large sums of money over many years.

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APPENDIX A
Human Subjects Processing Form

EASTERN KENTUCKY UNIVERSITY
HUMAN SUBJECTS PROCESSING FORM

DATE OF APPLICATION: **FEBRUARY 11, 2002**

TITLE OF PROPOSED RESEARCH: **MUSCULOSKELETAL INJURIES ASSOCIATED WITH SELECTED UNIVERSITY STAFF AND FACULTY IN AN OFFICE ENVIRONMENT – (NIOSH ERC PILOT PROJECT RESEARCH TRAINING PROGRAM GRANT #T42/CCT510420)**

PRINCIPAL INVESTIGATOR: **Steve Konkel, Ph.D., Assistant Professor**

DEPARTMENT AND COLLEGE: **Department of Environmental Health & Clinical Laboratory Sciences, College of Health Science (CHS)**

CO-INVESTIGATORS: **Thomas Fisher, Ph.D., OTR/L, CCM, Associate Professor, Dept. of Occupational Therapy; Carolyn Harvey, Ph.D., Associate Professor, Dept. of Environmental Health; Grad students: Troy Gibson & Linda Settles**

TOTAL PROJECT PERIOD: **February 15, 2002-October 15, 2002**

EXPECTED DURATION OF SUBJECT'S PARTICIPATION: **Observations will be conducted one time by a graduate assistant, approximately 45 minutes (see attachment). The questionnaire, to be completed by the participant, will require 10-15 minutes (see attachment) for a total of approximately one hour.**

RESEARCH STATEMENT: This research project, funded by NIOSH, is designed to apply a questionnaire completed by participants and an observational survey completed by graduate students in an office environment to evaluate risk factors which may lead to musculoskeletal disorders (WRMDs). We will use an informed consent letter to engage participants in the College of Health Sciences in this effort, and plan to implement controls to assure that the data collected and evaluated are used in a musculoskeletal assessment. We plan to pilot test the observational survey with several faculty prior to its implementation in the final study. In addition, we will analyze data on WRMDs from EKU's Environmental Safety and Health/Worker's Compensation office in aggregate form. The research will also illustrate ways to increase awareness of safety and injury prevention.

PROCEDURES: **The participants will be asked in person to complete a questionnaire, approximately 10-15 minutes in duration. As many as fifty volunteer participants from the faculty and staff located in Dizney, Rowlett and other CHS buildings will be asked to complete the questionnaire and to allow one or two graduate students to observe them at work. Observations of their work stations while they are performing routine tasks will require approximately 45 minutes to one hour. Participants will be provided with information concerning nature and purpose of the study prior to data collection. It is important to remember this is for research purposes ONLY and not to be used in any other manner. Participants will also be required to sign a consent form (see attachment) prior to data collection.**

Describe all foreseeable risks and discuss how risks are to be minimized.

There are no foreseeable risks inherent in this study. The voluntary participants are asked to complete the attached questionnaire and allow observation of their work stations. Complete confidentiality will be maintained throughout the study with no attempt to identify the research participants individually. All research materials will be kept in a locked file cabinet in a secure area of the Environmental Health Department's Dizney office and laboratory space and will be destroyed before a two- year period from project initiation. The Principal Investigator will have the keys. Data will only be reported without qualifiers to individuals or to individual worksite locations for analysis in aggregate form.

The number on the questionnaire will be used to match the observational data form. There will be no name-code number list.

How will confidentiality be maintained?

Complete confidentiality will be maintained throughout the study with no attempt to identify research participants. All research materials will be kept in a locked file cabinet as stated above and will be destroyed before a two-year period from initiation of project.

How will informed consent be obtained?

Participants in the study will be required to read and sign an informed consent letter. They will receive a copy of the letter containing information to contact the principal investigator if they have any questions. The form will provide information concerning the nature and purpose of the study. Participation in this study is completely voluntary with no coercion. Complete confidentiality will be maintained at all times.

Is this research in an exempt category?

Yes No

In the judgment of the principal investigator research subjects will be placed at :
X no more than minimal risk and likely zero risk.

Principal Investigator Signature

Date

Co-Investigator Signature

Date

Co-Investigator Signature

Date

Eastern Kentucky University
College of Health Sciences
Human Subjects Committee

Proposal Cover Sheet

Principal Investigator: Steven Konkel, Ph.D., co-investigators Thomas Fisher, Ph.D.,
Carolyn Harvey, Ph.D.

Proposal Title: Musculoskeletal Injuries Associated with Selected University Staff and
Faculty in an Office Environment –(NIOSH ERC Pilot Project Research Training
Program Grant #T42/CCT510420)

If student, faculty advisor: _____

Department: Drs. Konkel and Harvey Environmental Health; Dr. Fisher, Occupational
Therapy

Office phone: (859) 622-6343

Address to which communication should be mailed: Dizney 220

FOR COMMITTEE USE ONLY

Committee recommendations:

exempt

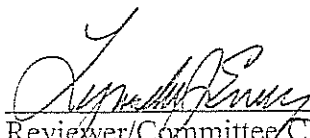
approved as no risk

conditionally approved as risk

disapproved

Approval is contingent on the following changes, additions, deletions:

None. Only requirement is submitting two copies of the proposal with revisions included.



Reviewer/Committee Chair
Approved: 10/24/96
Revised: 9/20/99

02/25/2002
Date

APPENDIX B
Informed Consent



EASTERN KENTUCKY UNIVERSITY
Richmond, Kentucky 40475-3135

College of Allied Health and Nursing
Environmental Health Science Department

220 Dizney Building
(606) 622-1939

INFORMED CONSENT
Musculoskeletal Injuries Associated With Selected University Staff & Faculty In An Office Environment

You are one of approximately fifty individuals being asked to participate in an Eastern Kentucky University research study. The purpose of this study is to measure work-related musculoskeletal disorders associated with an office environment. You will be asked to initially participate in an interview lasting less than 15 minutes. We would like for you to complete a short questionnaire during this time.

While participating in this study, you will be asked to allow two graduate students in the Departments of Environmental Health and Occupational Therapy to observe you while during your normal routine job tasks. These observations will be recorded and used to identify potential risk factors and/or work related musculoskeletal disorders. It is very important to realize that all information collected will be securely stored and treated in a confidential manner. Only those persons directly associated with the research project will have access to the data. Please let us stress that neither you nor your department will ever be identified by name in any reporting of this data. There are no risks associated with the activities or procedures of this study. Participation in this study is voluntary and participants may withdraw at any time.

It is anticipated the results of this study may provide the University as well as other universities with information rating ergonomic risk factors, qualitative factors workers perceive as relevant, and possible costs related to control and/or elimination of the risk factors.

If you have any questions or concerns regarding this study at any time, you may contact the principal investigator, Dr. Steve Konkel by telephone (859) 622-6343 or email, steve.konkel@eku.edu and or Dr. Lynnda Emery, Chair of College of Health Sciences Human Subject Committee (859) 622-6319. Thank you for your time and consideration of this request.

I have read and understand the above information. I have received a copy of this Informed Consent Statement and I agree to participate in this study. Your signature on this consent letter serves as your agreement to participate in this study.

Signature: _____ Date: _____

Name Printed: _____

Investigator's Signature: _____ Date: _____

APPENDIX C
Questionnaire

MUSCULOSKELETAL INJURIES ASSOCIATED WITH SELECTED UNIVERSITY STAFF & FACULTY IN AN OFFICE ENVIRONMENT

QUESTIONNAIRE

Questionnaire # _____

Today's date (Month/Day/Year) _____

1. Gender: Male _____ Female _____
2. Age:
 - a) 19-30
 - b) 31-40
 - c) 41-50
 - d) 51-60
 - e) >60
3. Weight:

a) <100 lbs	b) 101 - 130 lbs	c) 131 - 160 lbs	d) 161- 190 lbs	e) 191 - 220 lbs	f) > 220 lbs
-------------	------------------	------------------	-----------------	------------------	--------------

 Height:

a) < 5'	b) 5' - 5'3"	c) 5'4" - 5'6"	d) 5'7" - 5'10"	e) 5'11" - 6'1"	f) >6'1"
---------	--------------	----------------	-----------------	-----------------	----------
4. What is your position?
 - a) Clerk
 - b) Faculty
 - c) Administrative Assistant
 - d) Secretary
5. How many hours per week do you work?
 - a) 20-30
 - b) 30-40
 - c) 40-50
 - d) >50
6. How many years have you been in your present position?
 - a) 1-3
 - b) 4-6
 - c) 7-10
 - d) >10
7. What is the average period of time you work at you computer/typewriter without interruption?
 - a) < 30 minutes
 - b) 30 - 60 minutes
 - c) 1 - 2 hours
 - d) 2-4 hours
 - e) > 4 hours
8. How much time do you spend at your desk in an eight hour day?
 - a) 1-2 hrs
 - b) 3-5 hrs
 - c) 6-8 hours
 - d) > 8 hours
9. How many times do you leave your desk during the day?
 - a) 1-2
 - b) 3-4
 - c) 5-6
 - d) > 7
10. Does anyone else use your workstation?
 - a) Yes
 - b) No
11. Identify the things you feel need to change with your workstation (circle all that apply and feel free to add items on lines provided).
 - a) chair height
 - b) table/keyboard height
 - c) computer monitor height/ distance
 - d) lighting
 - e) add casters to chairs
 - f) _____
 - g) _____
 - h) _____
 - i) _____

12. Which best describes the lighting at your workplace?
- | | |
|--------------|--------------------------------|
| a) very good | d) irritating noise/flickering |
| b) good | e) glares |
| c) poor | |
13. Which position(s) and in what work situations do you experience discomfort?
- | | |
|--------------|-------------|
| a) Sitting | d) reaching |
| b) Standing | e) none |
| c) squatting | |
14. For what period of time do you maintain the position in answer 13?
- | | |
|-----------------|-------------------|
| a) < 10 minutes | e) 3-4 hours |
| b) < 30 minutes | f) > 4 hours |
| c) < 1 hour | g) not applicable |
| d) 1-2 hours | |
15. Can work surface height be adjusted? yes no
16. Can fixtures at your workstation be adjusted? yes no
17. Can the work surface be tilted or angled? yes no
18. Is a footrest available at your workstation? yes no
19. Is a document holder available? yes no
20. Do you have over the shoulder vertical reaches? yes no
21. What is your dominant hand? Right left
22. Is your station designed for both right and left handed people? yes no not sure
23. Frequency of over the shoulder reaches
- | | |
|--------------------------|--------------------|
| a) 1-10 times/10 minute | c) 1-10 times/hour |
| b) 1-10 times/30 minutes | d) < 10 times/day |
24. The temperature at work is:
- | | |
|----------------|--------------|
| a) comfortable | d) too humid |
| b) too warm | e) too dry |
| c) too cool | |
25. The air circulation is:
- | | |
|-------------|----------------|
| a) too high | c) comfortable |
| b) too low | d) stagnant |
26. Are you generally aware of current ergonomic legislation/regulation/rules and their status?
- | | |
|-------------|-----------------|
| a) No | c) very much so |
| b) Somewhat | |
27. All in all I am very satisfied with my job
- | | |
|-------------------------------|-------------------------------|
| a) Strongly agree | d) Neither agree nor disagree |
| b) Agree | e) Slightly disagree |
| c) Slightly agree | f) Disagree |
| d) Neither agree nor disagree | g) Strongly Disagree |
28. Have you added any furniture or fixtures to your office for which you paid? Yes no

APPENDIX D
Faculty and Staff Occupational Incident Analysis, 1994 – 2001

APPENDIX D

Faculty and Staff Occupational Incident Analysis, 1994 – 2001

YEAR	OCCUPATION	DEPARTMENT	DESCRIPTION OF INJURY	LOST WORK DAYS (LWD)
1994	Faculty	Music Dept.	Shoulder Soreness	-
	Asst. II	Library	Back/Head Injury	54
	Faculty	SCSBD Center	Multiple	87
	Faculty	Speech/Theatre	Multiple	1
	Faculty	Law Enforcement	Soreness Multiple	2
1995	Counselor	Model Lab	Multiple Injuries	1
	Secretary	Occupational Therapy	Pulled Back Muscle	-
	Faculty	Math/Stat/Comp	Multiple	-
	Dept. Sec.	Med/Serv/Tech	Back Pain	-
1996	TRC Coord.	Training Resources	Back Strain	5
1997	Faculty	Curr & Instruction	Back/Neck Strain	2
	Secretary	Bacc Nursing	Back Strain	-
	Faculty	Model Lab	Multiple	10
1998	Train Aide	Training Resources	Strained Rt. Wrist	1
1999	TRC Coord.	Training Resources	Carpal Tunnel	-
	Supervisor	Student Life	Strained Back	261
	Lab Manage	Chemistry	Strained Back	15
	Faculty	Occupational Therapy	Multiple	1
	Training Specialist	Training Resources	Multiple	8
2000	Faculty	Model Lab	Multiple	2
2001	Secretary	Special ED	Multiple	14
	Secretary	Enrollment	Strained Neck	4
	Administrator	Extended Programs	Strained Back	-
	Faculty	-	Soreness Back/Neck	-
	Secretary	Professional Develop	Strained Rt. Arm/Shoulder	-
	Faculty	Moore	Strained Back	-

APPENDIX E
Recommendations for an EKV Ergonomics Program

Appendix E

Recommendations for an EKV Ergonomics Program

In the course of implementing an ergonomics program for the University it is necessary to take several key steps to ensure an effective program. The United States General Accounting Office (GAO) issued a report on private sector ergonomics programs that will be very beneficial in the planning and implementation of effective ergonomics programs, particularly in office environments. The GAO report recognized six components to a successful program, which apply whether implementation is university-wide or limited to one department. An effective ergonomic program must have the following core elements to ensure that ergonomic hazards are identified and controlled to protect workers:

1. Management commitment
2. Employee involvement
3. Identification of problem jobs
4. Development of solutions for problem jobs
5. Training and education for employees
6. Medical management

Each effective program must maintain these elements; however, these elements can and must be tailored to fit the needs of the prospective institution.

Management commitment is the first step to an effective ergonomics program. Occupational safety and health literature stresses that management commitment is key to the success of any health and safety effort. Managers at EKV can demonstrate their commitment to sound work space design by considering ergonomics in major purchases, such as work stations and furniture like work chairs. Management commitment demonstrates the employer's belief that ergonomic efforts are essential to a safe and healthy work environment for all employees, and that employees are highly valued. Management commitment also demonstrates the employer's care and concern for the welfare of the individuals. Employees that experience this do not fear reprisal and exhibit commitment to make the program successful. Specific ways in which management commitment can be demonstrated include:

- assigning staff specifically to the ergonomics program and providing time during the workday for these staff to deal with ergonomic concerns;
- establishing goals for the program and evaluating results;
- communicating to all staff the program's importance, perhaps through policy statements, written programs, or both; and
- making resources available for the ergonomics program, such as by implementing ergonomic improvements or providing training to all employees or to staff assigned to the ergonomics program.

Involvement of employees is the second step in an effective ergonomics program. Involving employees in efforts to improve workplace conditions provides a number of benefits. These benefits include enhancing employee motivation and job satisfaction, improving problem-solving capabilities, and increasing the likelihood that employees will accept changes in the job or work method. Some of the ways in which employee involvement can be demonstrated include:

- creating committees or teams to receive information on ergonomic problem areas, analyze the problems, and make recommendations for corrective action;
- establishing a procedure to encourage prompt and accurate reporting of signs and symptoms of WRMDs by employees so that these symptoms can be evaluated and, if warranted, treated;
- undertaking campaigns to solicit employee reports of potential problems and suggestions for improving job operations or conditions, and;
- administering periodic surveys to obtain employee reactions to workplace conditions so that employees may point out or confirm problems.

Identification of problem jobs. or gathering the information to determine the scope and characteristics of the hazard contributing to the WRMDs is a necessary component of any ergonomics program. A straightforward way to identify problem jobs is for employers to focus on those jobs where there is already evidence that the job is a problem, because WRMDs have already occurred or symptoms have been reported. For this approach, employers could use the following methods to identify problem jobs:

- following up on employee reports of WRMDs, symptoms, discomfort, physical fatigue, or stress;
- reviewing the OSHA 200 logs and other existing records, such as workers compensation claims, on a quarterly basis; and
- conducting interviews or symptom surveys, or administering periodic medical examinations.

A more proactive approach is to identify problem jobs before there is evidence of an injury. Literature on WRMDs and our review of the workers compensation cases suggests to our NIOSH team that the physical plant jobs should be a University's first priority in assessing workplace conditions that may contribute to WRMDs. This approach could entail screening and evaluating jobs for particular workplace conditions that may contribute to WRMDs, such as awkward postures, forceful exertions, repetitive motions, and vibration. Screening and evaluation could be achieved through walk-through observational surveys, interviews with employees and supervisors, or the use of checklists for scoring risk factors. Many supervisors have extensive period on the job, and can serve as a tremendous resource in efforts to improve ergonomic design for workers as well as avoid workplace injuries, including WRMDs.

Development of solutions. The first step in elimination of the hazard is to analyze the job or job tasks to identify the ergonomic hazards present in the job. Analyzing or evaluating an employee's workstation to identify the ergonomic hazards present in the job can involve a variety of activities, including:

- observing workers performing the tasks, interviewing workers, or measuring work surface reach and reach distances;
- videotaping a job, taking still photos, or making biomechanical calculations; and
- administering special surveys, such as the one described as the focus of our NIOSH Education and Research Center (ERC) Pilot Project research grant, # T42/CCT510420.

Once ergonomic hazards have been identified, the next step is to develop controls to eliminate or reduce those hazards. Efforts to develop appropriate controls can include:

- brainstorming by employees performing the job in question or by team members performing the analysis;
- consulting with vendors, trade associations, insurance companies, suppliers, public health organizations, NIOSH, labor organizations, or consultants;
- purchasing new office equipment (work stations, chairs, footrests, glare screens, for example) or modifying office configurations and equipment, and
- following up to evaluate the effectiveness of controls.

The hierarchy of controls is as follows:

- Engineering controls are generally preferred because they reduce or eliminate employee's exposure to potentially hazardous conditions.
- Administration controls refer to work practices and policies to reduce or prevent exposure to hazards, such as scheduling breaks, rotating workers through the jobs that are physically tiring, training workers to recognize ergonomic hazards, and providing instruction in work practices that can ease the task demands resulting in a burden. Education of employees to become aware of the balance required to improve workplace conditions in an economically sound fashion is part and parcel of sound management of ergonomic programs.

Training and education for employees. Recognizing and filling different training needs is an important step in building an effective program. The different types of training that a facility might offer include:

- overall ergonomics-awareness training for employees so they can recognize general risk factors, learn the symptoms and procedures for reporting WRMDs, and become familiar with the process used to identify and control problem jobs;
- targeted training for specific groups of employees because of the jobs they hold.
- awareness of the costs of workers compensation and rehabilitation programs, both to the employee and to the company.

Medical management. An employer's medical management program is an important part of its overall effort to reduce WRMDs, even though this program may exist regardless of whether the employer has implemented an ergonomics program. A medical management program emphasizes the prevention of impairment and disability through early detection of injuries, prompt treatment and timely recovery for the employee. . Different ways facilities can carry out medical management include:

- encouraging early reporting of symptoms of WRMDs and ensuring that employees do not fear reprisal or discrimination on the basis of such reporting;
- ensuring prompt evaluation of WRMD reports by health care providers;
- making health care providers familiar with jobs, perhaps through periodic facility walk-throughs or review of job analysis reports, detailed job descriptions, or videotapes of problem jobs; and
- giving employees with diagnosed WRMDs restricted or transitional duty assignments until effective controls are installed in the problem job, and conducting follow-up monitoring to ensure that they continue to be protected from exposure to ergonomic hazards.

Developing an ergonomics program at Eastern Kentucky University utilizing the aforementioned six core elements will ensure an effective and valuable plan that will benefit both employees and employer. Institutions benefit from employees that feel valued, and employees benefit from institutions that care for their physical and mental well-being.