Design & Environmental Analysis 670

Class Term Project | Radiology Workplace Assessment
Client | Henry Ford Hospital - Radiology Department
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INTRODUCTION

There has been a major shift within the last decade from traditional film x-ray image revision in a light box (hard copy) to digital x-ray image revision on a computer monitor (soft copy). This increased computer use is making computer workstations and ergonomic factors a very important concern for radiologists. The risk for developing work related musculoskeletal disorders (WMSD) is increasing. Work related musculoskeletal disorders are injuries of the muscles, nerves, joints, tendons and ligaments resulting from workplace conditions such as poor working posture and poor placement of equipment. These types of injuries are on the rise in the United States, especially in response to the increased use of computers. It has been reported by the United States Bone and Joint Decade that approximately one out of every seven Americans report a musculoskeletal impairment and billions of dollars are spent on treating musculoskeletal disorders each year. Some common locations of WMSD, especially applying to computer workstations, are discomfort are in the neck, shoulder, back, arms, wrists, hands, thumb, thighs and butt. Symptoms indicating problems with these areas are pain, tingling, numbness, swelling, inflammation, stiffness, cramping, and reductions in range of motion (Carnegie Mellon, 2006).

Common injuries associated with frequent computer use in the workplace include Repetitive Strain Injuries (RSI), Carpal Tunnel Syndrome (CTS), and are frequently associated with poor body postures. Postures that cause static loading and move the body out of neutral postures can affect circulation, irritate or apply pressure to muscles, tendons, ligaments, and nerves. Properly adjusting computer workstation chairs, desks, and computer monitor heights, providing proper footrest support, and placing most frequently used items close to the user minimizes the amount of time spent in poor postures. Repetitive strain injuries occur from frequent movements such as clicking a mouse, using a dictation handset, and typing on a keyboard. Carpal tunnel syndrome is a disorder that occurs when the median nerve, which runs

from the forearm into the hand, becomes compressed at the wrist. This may be caused when the tunnel, which encompasses the median nerve and tendons, narrows or becomes inflamed (NINDS, 2006). Carpal tunnel is most frequently associated with non-neutral positions of the wrist while using a computer mouse or keyboard and/or resting the wrist on surfaces such as desk or computer surfaces and edges. Other WMSDs include Tendonitis which is inflammation of the tendons, Tenosynovitis which is irritation of the synovial membrane, and Bursitis which is inflammation of the bursa located in the shoulder, elbow, or knee. A large number of WMSDs such as these are diagnosed as each year. Workplaces that require repetitive movements and prolonged or awkward sitting postures at non-ergonomic workstations put their employees at risk.

Other workplace concerns, especially for visually intensive jobs such as x-ray image revision include eye strain, blurred vision, and headaches which are symptoms of computer vision syndrome. Computer vision syndrome is a collection of problems resulting from prolonged computer use. Radiologists spend a significant portion of the day using computer monitors to review images which raises questions about possible performance and health effects and what types of computer monitors should be used. Vertinsky and Forrester (2005) surveyed 2,700 radiologists on their viewing method, work habits, and workstation design. From the findings they suggest that radiologists use screens that eliminate flicker, take frequent short breaks and limit the number of CT screening studies interpreted to reduce the occurrence of eye strain. An article pointing out the technical and clinical considerations of radiology workstation design by Krupinski and Kallergi (2007) discussed similar results relating eye strain to the long hours that radiologists spend reviewing x-ray images on digital displays every day. The article also emphasized the importance of selecting computer workstations that offer high diagnostic power and ergonomic efficiency. Monitors should be selected that minimize eye fatigue and maximize viewing detail.

Two types of digital display monitors in use today are liquid crystal displays (LCD) and cathode ray tube (CRT) displays. LCD monitors now have sufficient luminance levels and contrast ratios to rival the traditional CRT monitors. They also eliminate geometric image distortions and flicker in addition to improving visual work performance and reducing spectral glare (Hedge, 2003). It is important to note that LCD monitors still have issues concerning off-center viewing. This is not a problem if it is one radiologist reviewing the digital images but when two individuals are viewing an image and he or she is as little as 45 degrees off center, visual diagnostic accuracy decreases substantially (Krupinski & Kallergi, 2007). Having properly adjusted display monitors is important, especially for image revision on LCD monitors.

Another factor that may influence how well radiologists read digital x-ray images is lighting. Two ergonomic issues concerning lighting were addressed by Arenson, Chakraborty, Seshadri, and Kundel (1990). The first was the average room illumination and the second was the reflection of light from monitor surfaces. Average room illumination or diffuse illumination has been shown to negatively affect contrast perception of images for both monitors and light boxes. It is also important to eliminate direct light sources that produce spectral glare on monitor surfaces. When the study was done, they only looked at CRT monitors. Since then, LCD monitors have been adopted by many radiology practices and therefore the concern about actual monitor surface glare has been reduced. Lighting issues such as these have adverse effects on the visual performance of radiologists. Addressing these issues and improving image perception is important to these types of physician's practices and the patients that rely on them.

The purpose of this study was to identify the frequency of WMSD symptoms in the radiology department and to try and identify the specific workstation characteristics that influence the occurrence of these symptoms.

METHODOLOGY

Subjects

Sixty radiologists at the Henry Ford Hospital in Detroit, Michigan were asked to participate in this study to investigate the discomfort and potential risk of work related musculoskeletal disorders. Of those that were asked, 50% (n=30) participated by answering questions in an online survey. All radiologists worked at shared computer workstations for diagnostic radiology and all workstations consisted of the same equipment, set-up and adjustment capabilities.

Measures

This data for this ergonomic and risk assessment study was collected through an online survey developed in Websurveyor version 3.6.120 for Windows, provided by Academic Technology Center, Distributed Learning Services, Cornell Information Technologies, Cornell University. The final survey consisted of 24 questions (See Appendix) made up of Likert scale items and qualitative open-ended questions. The radiologists that participated in the survey were first asked to identify the area of the head and upper body in which they experiences discomfort, the frequency and bothersome of discomfort, and to what extent the discomfort causes an interference with their ability to work. The following set of questions asked about the frequency of discomfort for specific areas of the body based on indicated components of the workstation, including the computer monitor, keyboard, mouse, chair, telephone, dictation handset. If they experienced any discomfort due to a piece of workstation equipment, they were then asked to indicate the severity of interference with work.

Data Analysis

The data was extracted from Websurveyor and entered into SPSS 15 statistical software for analysis. Indices were created for questions that asked about discomfort for each of the

workstation components. The indices were calculated by multiplying the responses to the questions of whether each individual workstation component was bothersome and resulted in discomfort, or interference of work.

Areas of the body that were asked regarding the discomfort associated with viewing x-rays with the workstation computer monitor included the neck, upper and lower back, left and right shoulder, eyes and head. The range of index values for these seven indices was 1, meaning no report of discomfort, to a value of 36, indicating a frequency of all the time, very bothersome and substantial interference with the subjects' ability to work. The indices created for the responses to mouse, keyboard, chair, dictation handset, and telephone discomfort ranged in value from 1-12.

Whether or not the subjects made adjustments to their workstation components was used as an independent variable for analysis. Dependent variables were indices and frequency of discomfort regarding each of the components of the workstation.

RESULTS

Monitor

Index frequencies for discomfort due to issues with the computer workstation monitor were found through statistical analysis. Areas of focus for the computer monitor were as follows: neck; left and right shoulder; upper and lower back; eye strain; and headache. The areas of the upper body that were reported as having the most discomfort in regards to the workstation monitor included the neck and lower back.

33.3% of the subjects did not answer for questions regarding the neck due to issues with the computer monitor. Of those that responded, 23.3% (n=7) had an index value of 2. 20%

(n=6) were found to have an index value of 8 and 13.3% (n=4) had a value of 12, indicating a sever level of discomfort in the neck due to the use of the monitor.

The questions for upper back were not answered by 76.7% (n=23) of the subjects. 20.1% (n=6) were found to have an index value of 4 or greater, which indicates some issue of discomfort. The lower back questions were unanswered by 46.7% of the subjects. Of the respondents, 26.7% (n=8) had a value of 2. 13.3% (n=4) had an index value of 8 or 12. Finally, one respondent was found to have an index value of 27, indicating very sever issues with the lower back.

63.3% (n=19) of the subjects did not answer questions for the right shoulder. 13.3% (n=4) were found to have an index value of 4 and 10% (n=3) subjects had a value of 2, meaning moderate levels of discomfort in the right shoulder. Additionally, one respondent had an index value of 24, indicating a sever issue with their right shoulder due to the use of the workstation computer monitor. Overall, the left shoulder was less of an issue since 73.3 % (n=22) did not answer. Of the respondent, the majority (10%) had an index of one, indicating the left shoulder never caused discomfort.

56.7% (n=17) did not answer questions regarding frequency of headaches due to use of the computer monitor. 13.3% (n=4) were found to have a value of 2. Eight respondents (26.7%) had an index value between 4 and 12.

When asked about issues with eye strain or irritation, 46% (14) chose to not respond. Of the respondents, 40% (N=12) had an index value of 4 or below.

Mouse

Areas of focus for the workstation computer mouse included the following for both right and left sides of the body: upper arm, forearm, wrist, and hands The areas of the upper body that were reported as having the most discomfort in regards to the workstation monitor included the neck and lower back.

The questions for upper arm regarding the computer mouse were not answered by 73.3% (n=22). The remaining 26.7% (n=8) of respondents had an index value of 1 or 2. The questions for dealing with forearm were not answered by 73.3% (n=22), of those who responded 20% (n=6) had an index value of only 2.

The questions regarding the wrist due to use of the computer mouse were not answered by 50% (n=15) of the subjects. Of the respondents 23.3% (n=7) had an index value of 2; 20% (n=6) had an index value of 6; 6.7% (n=2) had an index of 4.

46.7% (n=14) of the subject did not respond to questions about the discomfort in their hand due to the use of the computer mouse. While 16.7% (n=5) had a low index value of 2, 33.3% (n=10) had an index value of 4 or 6. Additionally, one respondent had a value of 9, indicating an issue of discomfort with their mouse.

Keyboard

For questions involving the discomfort associated with using the workstation keyboard, areas of the body that were focused on included the upper and forearms, the wrists, and hands. These regions were separated questioned and coded for the left and right sides of the body.

The data found regarding the left and right upper arm did not attribute to discomfort for subjects of the study, as reports indicated high frequency of non-responses or low index values of 1 or 2. A similar pattern was shown in the data for the left forearm, wrist or hand.

The questions regarding discomfort for the right arm were not answered by 86.7% (n=26). One subject (3.3%) was found to have an index value of 1, 2, 4 and 6.

The right wrist was found to be issue for 23.3% (n=7), who were found to have an index value of 2 or 6. 73.3% (n=22) did not respond to these questions for wrist discomfort. The questions for the right hand was not answered for 83.3% (n=25), but 16.7% (n=5) had an index value between 2 and 6.

Chair

The upper body regions that were questioned regarding issues with the discomfort for the workstation chair were the neck, both shoulders, upper and lower back, buttocks and thighs. Of these regions analyzed, the neck was shown to have the highest discomfort index values.

56.7% (n=17) did not respond to questions involving the discomfort experienced in the neck due to the workstation chair. 20% (n=6) had an index value of 2; 10% (n=3) had a value of 4; and 13.3% (n=4) had an index value of 6. This shows that 1/3 of the respondents had an issue with their neck due to the use of the workstation chair.

86.7% (n=26) did not respond to questions involving the left shoulder and one subject (3.3%) for index values of 1, 2, 4 and 6 were found. 80% (n=24) didn't respond to questions for the right shoulder. Of those that did respond, 6.7% were found for index value of 2 and 6.

The questions for upper back were not answered by 80% (n=24) of the subjects. 10% (n=3) were found to have an index value of 2; 3.3% (n=1) had a value of 4; and 6.7% (n=2) had a value of 6.

53.3% (n=16) didn't respond to questions for the lower back regarding the workstation chair. Of those that responded, 30% (n=9) had an index value of 2 and 13.3% (n=4) had an index value of 4 or 6.

90% (n=27) did not answer questions about their thighs and 10% (n=3) had an index value of 2 or 4. 73.3% (n=22) did not respond for questions regarding discomfort in the buttocks. 20% (n=6) had an index value of 2 and 6.7% (n=2) was found to have an index value of 4.

Adjustment

Frequency of adjustments for workstation components (i.e. chair, keyboard, monitor, mouse, etc.) were correlated with the indices created based upon participant ratings of discomfort. Results indicated that adjustment frequency was not significantly associated with discomfort indices for any of the workstation components. We also examined discomfort ratings for those

participants who reported that their workstation components were either (1) not adjustable or (2) were never adjusted. No significant difference existed between discomfort ratings between participants who did and did not adjust their workstation components.

DISCUSSION

The goal of this study was to assess the workstation set up of radiologists at Henry Ford Hospital and to identify which workstation components contributed to the most discomfort. Discomfort associated with radiology workstations may result in decreased work efficiency, lower satisfaction, and cumulative strain injuries (CSI).

Results of this radiology workplace survey indicated that certain body regions were negatively impacted by the workstation setup. Those that were reported as having the highest frequency of discomfort were as follows. The neck and lower back were reported as contributing to the most discomfort for radiologists with us of the computer monitor. Discomfort in the right hand was reported as a result of use of the mouse, and for the workstation chair, the neck was reported to have the highest ratings of discomfort.

Discomfort indices of participants who did and did not adjust their workstation components were examined. It was found that no significant differences existed between either group based upon adjustment frequency. Furthermore, distributions of discomfort ratings also indicated that those participants who did not adjust had lower discomfort indices. Therefore, it is possible that no adjustments were made because no discomfort was experienced for these participants.

No significant associations were found between adjustment frequency and discomfort indices. Other external factors other than adjustment, such daily hours of work, duration of work, posture, ergonomic knowledge, age, and gender may have contributed to these differences. Unfortunately, the survey conducted did not ask for these demographic factors.

In addition to the lack of independent variables collected in the survey, many other suggestions could be made for future research. Increased sample size would aid in the finding of significant associations. Future research may also explore the impact of an ergonomic intervention on ratings of discomfort for the Henry Ford Hospital radiology department.

Even if further research is not conducted at the Henry Ford Hospital, results from this study reveal that greater knowledge of ergonomic issues may reduce discomfort levels at the workstation. An ergonomic intervention to educate radiologists about proper workstation component adjustment, posture, and frequency of rest breaks should be provided.

Appendix A: Survey Question Example

3) With which hand do you normally use the computer mouse with during a typical x-ray reading session?

☐ Right ☐ Left

4) Using the **computer mouse:**

	During a typical **x-ray reading session**, about how often do you experience **discomfort** in the following regions of the hand and arm that you mouse with?				How **bothersome** is the discomfort you experience?		
	Never	Some of the Time	Most of the Time	All of the Time	Slightly	Moderately	Very
Upper Arm	☐	☐	☐	☐	☐	☐	☐
Forearm	☐	☐	☐	☐	☐	☐	☐
Wrist	☐	☐	☐	☐	☐	☐	☐
Hand	☐	☐	☐	☐	☐	☐	☐

5) Has the discomfort you have experienced using the computer mouse ever interfered with your reading session work?

☐ Yes ☐ No

6) During a typical x-ray reading session, do you use a workstation computer keyboard?

☐ Yes ☐ No

Appendix B: Open-ended Responses

Please comment on any aspect of the workstation you are having difficulty with or is contributing to your discomfort:

sometimes i get pain around my elbow when I rest it on the table during dictations

Mouse index finger may be quite arthritic over a career. Wonder if trackball would be better as can alternate fingers used.

Mostly the mouse. My wrist starts hurting after about half of the day.

angle of the screens. I have bifocals, and I need to be above the screens and looking down for optimal ease of use. It is very difficult to obtain this position as most monitors are positioned higher. i can't raise my chair high enough. at maximum chair height, my legs don't fit under the work station.

What suggestions do you have that would make your workstation more comfortable?

Ergonomic designed equipment to be available and education, how to design proper work environment

elbow rests

Trackball.&CR; Make all tables adjustable.

Our workstations are very adjustable. No complaints.

1. Lumbar support for chairs.&CR;2. headset for dictation instead of dictaphones.&CR;3. roller ball mouse

have both the monitor height and table height adjustable. Also, monitors cannot be angled at most of our workstations.

different mouse

Bean bag wrist rests instead of gel/others. Gel is often too hard as well and puts pressure on carpal tunnel. Proper ergonomic education for all staff/residents.

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