ARE STUDENTS AWARE OF ERGONOMICS OF COMPUTER USES?

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ABSTRACT
This study explores the extent of awareness of an undergraduate of the principles and practice of workstation ergonomics. The level of work-related upper limb disorders (WRULDs), which can be a consequence of computer workstation use, was explored to highlight the extent that the problem was present in those about to enter (or re-entering) the workplace. The survey results shown that the level of reported symptoms is high while the level of awareness of good workstation ergonomics is low; that undergraduates’ use of computers exposes them to the known risks associated with computer use; that there were a number of possible relationships between current postural practice and the level of reported symptoms.

Keywords: Computer Use, Risk Assessment, Ergonomics, WRULDs, Multi-Media Technologies, Students Teaching.

1. INTRODUCTION
Musculoskeletal disorders are the most frequently self-reported, illness in the UK, yet there is little evidence that prevention and training is being integrated into university teaching. The Overall aim of this study is to explore the awareness of ergonomics of undergraduate students who are 18 years old, or above, using a survey questionnaire. The findings have been analysed to consider the likely potential for developing WRULDs and back pain.

Research in the UK into the prevalence of WRULDs indicated that, in 1994, the cost to the economy, alone, for these disorders, was in the region of £1.25 billion. Musculoskeletal illnesses accounted for the greatest number of people retiring with ill health and for the highest category of workdays lost through absence due to illness [1].

With wide availability and high performance of computers and Internet, more and more students start using computers earlier than ever before. It is evident that away from the home, schools and universities are the largest provider of computer access to young people. In some colleges there is a requirement for all students to complete their written work on a word processor and for those taking computer based courses to submit computer produced course work. In addition, due to the free and unlimited access to Internet at higher education institutions, students will ‘fill in’ time on the Internet, which adds considerably to both the length of computing sessions and the frequency of computer use each day.

Universities are currently not required to undertake specific training for undergraduates in the use of computer workstations; the only aspects of computer laboratories that are covered by health and safety legislation (beyond the compliance of the computer equipment to electrical and radiation safety (TCO 99) are the humidity, temperature and lighting [2].

This study was to:
1. To explore students ergonomic practice whilst using a computer workstation.
2. To relate this to current research evidence and identify if students are aware of the health risks of using computer workstations.

The objective of the study was to identify if current computer usage by undergraduates conforms to the recommended ergonomic models or deviates from them. If it is the latter then issues discussed above underline the importance of improving students’ awareness and

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promoting high standards of practice by creating an environment in which the risks of non-compliance are understood.

2. LITERATURE REVIEW

2.1 The Link between Upper Limb Disorders and Working Practices
WRULDs have attracted a wide range of researcher interests. Buckle described some of the research by Preil and Corlette who used videotape and observation techniques, and Armstrong, Yen and Radwind [3, 4], who applied electronic approaches (electromyography) to measure the forces acting upon the muscles [5]. Kier employed an invasive approach to measure carpal tunnel pressure, a known factor in Carpel Tunnel Syndrome (CTS), by inserting a saline filled catheter into the carpal tunnel of the right hand, which was connected to a pressure transducer [6]. Many more studies have used analysis of self-reported symptoms across different study groups to explore the relationships between the incidence of complaints and work. There are a number of articles to be found on the Internet detailing personal experiences as a result of these illnesses. A good example is an article by Jackson writing in Crossroads, the ACM Student Magazine in which he describes how he began to experience repetitive strain injury (RSI) symptoms, which eventually caused him to give up his computer science course [7].

2.2 Causes of Work Related Upper Limb Disorders
Causes of WRULDs cited in research papers and reported in this study [8-11]; include inappropriate posture, repetitive movements, and some psychosocial situations. Although most of the studies have been conducted in the workplace some investigations have been aimed at students. In one study ‘over fifty percent of the undergraduate students reported having pain and discomfort at the computer and 12.5% reported problems after only one hour or less at their workstation’[12]. Such claims indicate that students are at risk of developing WRULDs and this forms the main impetus for the study, to establish the level of awareness and, any problems, a sample group of UK students may be experiencing.

2.3 Ergonomic Factors
The European Agency review raises the issue that in addition to the physical forces acting upon a tissue there are many contributing factors to the development of neck and upper limb disorders, including work organisation, psychological work factors, the physical environment and that ‘many experts are of the opinion that a single common pathway that links exposure in the workplace to the development of neck and upper limb musculoskeletal disorders cannot be identified’ [13]. This weight of opinion therefore offers confidence to the justification of the parameters of investigation to focus the study on the broad level of awareness of ergonomic factors amongst the student group.

Little research was found specifically regarding undergraduate workstation use, although WRULDs symptoms have been recognised and reported within this group. The absence of specific evidence regarding the impact of computer use on undergraduates drives this study, which attempts to capture a ‘snap shot’ of the current level of awareness of ergonomic computer use.

3. METHOD AND PROCEDURES

3.1 The Questionnaire and Sample
In order to meet the study aims, a survey of students was considered appropriate using a self-assessment questionnaire to gather quantitative data. Previous studies have used these questionnaires to collect data about how people use their computer equipment [14, 15]. The questionnaire employed by the researchers went beyond a measure of incidence of discomfort to explore students’ posture, which is accepted to be one of the main factors in the development of musculoskeletal disorders. The study used a random sample of 150 undergraduate students from within three different disciplines attending a university in the south west of England.
3.2 Questionnaire Design
The challenge of designing the questionnaire was to ensure that the content and structure would generate reliable, valid data meeting the research aims (Parahoo, 1993). The questionnaire was modelled on previous questionnaire designs [14, 15] capturing the most relevant components. This study wanted to explore commonly assumed postures and work practices which could be compared to good ergonomic practice. This was chosen to enable discussion of the prevalence of physical complaints (symptoms) with the practices adopted by the students.

3.3 Ethical Considerations
It is imperative in all research that those involved are in no manner harmed by the process. The respondents to the questionnaire were assured of anonymity and confidentiality by not requesting any personal information from which they could be identified.

4. RESULTS ANALYSIS

4.1 Introduction
There were a total of 17 questions in the questionnaire. The analysis and results of the questionnaire are reported in relation to the study aim of assessing the level of awareness of ergonomics for computer workstations among students. The findings that are presented are based on the responses from 150 questionnaires; of which 130 were returned. This equated to an 87% response rate, (n=130). Three questionnaires were returned incomplete and thus did not meet the criteria for inclusion in the study; this data was not included in the results.

4.2 Results from the Questionnaire

Questions 1 to 2 established the frequency, intensity and nature of computer use. 91% of the sample uses a computer for 5 days or more with 50% reporting their computer use as daily. Of the total sample 35% reported working in sessions in excess of 3 hours, with a mean of 2.59 hours per session across the 7 day sample, 3.22 hours across 6 days and 1.98 hours for those working five days. This results in a SD of 0.62 indicating that all students studying over 5, 6 or 7 days work a similar number of hours The weighted mean (to allow for the different sized samples) session length for 7, 6, 5, and 4 days is 2.53 hours or 2 hours 31 minutes per session (Figure 1). Due to the limitation of length of paper, the graphs and tables for all other results have been removed from the paper. They are available from the authors.

![Figure 2 the number of days and length of computing session (n=127)](image)

Question 3 asked the sample to indicate the average number of times in one hour the students got up from their workstation. 11% took no breaks at all but these were evenly distributed across the sample as a whole and therefore represent only a small fraction for each group of students. A majority of 71% took breaks, every hour, which is in keeping with the recommendations.

Question 4 aimed to determine the nature of computer use and in particular the most used input device. The respondents came from varying disciplines including Multimedia, Marketing, and Business and it is expected that they would have different frequencies of use for the mouse and the keyboard. It has been found that all students utilised both imputed devices but that Multimedia students have an 87% level of using the mouse whilst both
Marketing and Business students have only 21% and 30% respectively. This indicated that there are areas where the subject discipline influences use of computer equipment. Research has shown that input device use has specific implications for the incidence of WRULDs and the study will explore this finding in the Discussion Section.

Questions 5 to 10 were designed to explore the posture of the student whilst using a workstation. The results to this section have been collated to reflect the deviation from the ‘correct’ posture. Only two respondents identified a complete set of correct postures, both of which had received workstation ergonomics training at work and reported no symptoms of work-related disorders. 25% of the sample adopts this posture of leaning forward that makes the back too rounded and is said to increase back discomfort. The other positions are also frequently recorded and have the higher incidence of back pain and the lowest level of incidence of symptoms.

Question 6 identified the direction of the head while viewing the monitor. Most of the sample group sit facing the monitor, which is the ‘correct’ position. The results of the frequency of this neck posture are cross-referenced with the neck posture identified in Question 7 and compared to the reported incidence of neck pain. It has also found that a significant percentage (from 30% to 100%) of the sample have reported neck pain.

Question 8 asked respondents to indicate the most common position of their arms in relation to the side of their body whilst using the mouse and keyboard. The position of the hand/wrist in relation to the body and to the keyboard/mice has been identified as a causative factor of Carpal Tunnel Syndrome (CTS), which is a cumulative disorder of the hand and wrist. More than 50% adopted the ‘correct’ position although this is an instance where computer design, the straight standard keyboard located in front of the monitor, has been identified as inappropriate as it causes the arms to be extended to one side. There are various alternative keyboard arrangements available but they have yet to be adopted for mainstream use.

Question 9 was about the angle of the hand / wrists relative to the keyboard and the corresponding level of wrist pain symptoms reported by respondents. The data from this question shows a clear indication of a relationship between the adoption of the ‘correct’ position and the incidence of symptoms. In this instance 24% of the sample that adopted the correct position recorded symptoms whilst 40% of those using deviated hands/wrists experience wrist pain or discomfort. When the 24% that adopted the correct position are cross referenced with other hand/wrist position, nearly a quarter of these adopted upward or downward flexed hand, which could account why the sample had a high incidence of symptoms.

Question 10 recorded the flexing of the wrist from the middle or ‘neutral’ position. The neutral position, which is the preferred position, was recorded as the most frequently used. Next the upward tilting ‘extension’ of both left and right hand. This position is in keeping with the design of most keyboards that have ‘feet’ to raise the board to an angle, which has been challenged as a built in flaw and is probably a remnant of the design of the computers predecessors, the typewriter. Fewer people indicated using wrist flexion, the downward pointing hand.

Question 11 investigated the level of awareness of workstation factors that are controllable by the users and which impact on its ergonomic efficiency. Using a Likert rating scale of 1-4 with 1 being unimportant and 4 being important respondents were asked to rate the importance of some of the components that make up a workstation. There were six questions covering the following:

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<th>Chair height</th>
<th>Desk size</th>
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<td>Size of characters on the screen</td>
<td>Position of the keyboard</td>
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<td>Workstation lighting</td>
<td>Suitability of software for the task</td>
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Taking all six questions together the participants scored 81.6%, which indicates that the majority of the participants have an understanding of the importance of these components in an ergonomically correct workstation.

**Question 12** is an exploration into the prevalence of psychosocial factors that are known, in combination with physical factors to promote the incidence of WRULDs. Three questions were asked about the participant’s perception of their workload, which could be seen as a possible cause of stress and fatigue. It can be seen from the chart that there is a perception of a consistently high level of work demand with only 21% of the sample not reporting any stress factors at all.

The result from **Question 13** indicated a majority of the students (72%) fall within the 18 –24 grouping. Age has been reported as a factor in the incidence of WRULDs in the population, generally with older people (35 – 50) experiencing a higher level of symptoms. This study had 15 people, or 12% of participants, in the age range of 32-38 years and above.

**Question 14** measured the gender ratio and found the sample to be 61% male. A number of cross-references were made with gender, in particular the incidence of symptoms. The results have indicated that women are more likely to develop WRULDs. The reasons for this are complex and will be discussed later in the report. In the study sample the proportional incidence of symptoms showed that there was little variance in the reporting of symptoms between genders. The difference between 81% and 88% is not big enough to draw a general conclusion due to the sample size.

**Question 15** gathered data on the prevalence of training within the sample. It found that there were three main locations in which training took place: at school (25%), in university (15%) and at work (22%). The results have shown the proportion of training within the sample, indicating that over half the sample (54%) had received some level of instruction. The questionnaire did not probe the frequency or duration of this instruction but the responses indicate that it would be appropriate to suggest some level of awareness is gained from training, which should influence the responses to some of the questions.

**Question 16** asked the respondents to state which computer they based their answers upon. The basis of this question was to differentiate between the university equipment, which in most instances could not be significantly adjusted for individual use, and home computers, which are assumed to be under individual control. The majority of students use their own equipment (71%) but some of them use the university equipment as well. One of the problems highlighted in the litigation factors raised earlier has been in establishing whether the injuries occurred ‘at work’ or elsewhere. The implications for undergraduates are explored in the discussion.

**Question 17** asked about the incidence of symptoms of WRULDs present in the sample group. These are broken down into categories, which follow the definitions of symptoms used in risk assessments produced by National Institute for Occupational Safety and Health (NOISH 1997) and Hewlett Packard (2002). There are five categories each describing a type of feeling, sensation or pain a person may experience. The five categories are sub-divided into particular parts of the back and upper limbs that may experience these sensations. It has been found that the proportion of the sample that experience these symptoms was 83% and that there is a coexistent correlation between the number of respondents and the incidence of symptoms. The incidence of symptoms to the number of responses has a correlation coefficient of around 0.98. The amount of correlation between two sets of data can range from strong through to weak. The data from the study indicates a correlation coefficient.

**5. CONCLUSIONS**

This study has clearly demonstrated that students, the majority of whom were under 24 years old, experience pain or discomfort whilst using their computers. Further, the type, frequency and length of sessions falls within the definition of a ‘user’ as set out in the DSE Regulations and therefore they are exposed to the dangers that the Regulations are designed to help
minimise. A comparison of adopted postural practice and the recommended practice indicates that the students are either unaware or possibly not positively motivated to take some simple steps to lessen their vulnerability to WRULDs. It would appear that the discipline that is followed is not a determinant factor of a level of risk but that intensive mouse users could be more vulnerable as this group are often singled out in research as a high-risk group. The level of awareness of the six health and safety factors associated with good workstation set up e.g. lighting, appeared high, but the method of questioning, in all likelihood would have disguised true understanding behind these critical factors. The study concluded that more in-depth research into the impact of computer use within universities is required to establish if training and awareness raising would help to alleviate the potential for developing workstation related disabilities.

6. REFERENCES