A STUDY ON UPPER EXTREMITY MUSCULOSKELETAL DISCOMFORT RELATED TO COMPUTER USE AMONG COLLEGE STUDENTS

By

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ABSTRACT

A limited number of studies have focused on computer-use-related upper extremity musculoskeletal discomfort among college students, though risk factors in terms of exposure may be similar to professional workers who use computers. The use of computer has increased among college students, as have musculoskeletal symptoms. There is evidence that these symptoms can be reduced through ergonomics and education approach. From literature reviews, it was found that the following were risks factors related to computer use: body posture, duration of computer use, psychosocial factors, work environment, complaints and history of musculoskeletal problems. In this study, the associations of these independent variables to upper extremity musculoskeletal discomfort (dependent variable) among college students were determined. In other words, the purpose of this study was to examine whether the risk factors for upper extremity musculoskeletal discomfort among college students would significantly lead to musculoskeletal discomfort especially upper extremity musculoskeletal discomfort. A cross-sectional correlation study was carried out to determine the correlation. A total of 132 questionnaires were distributed, only 130 (98.5%) students completed a self-administered questionnaire concerning the risk factors and the upper extremity musculoskeletal discomfort specifically associated with computer use. The research hypotheses were tested using Pearson Correlation Analysis. The results revealed that body posture, psychosocial factors, complaints and history of musculoskeletal pain were significantly correlated to upper extremity musculoskeletal discomfort. However, duration of break time and work environment were on the contrary. Multiple Regression results revealed that 35.8% of the variance (R-square) in upper extremity discomfort has been significantly explained by the six independent variables. There were other factors that need to be considered that might contribute to upper extremity musculoskeletal discomfort. The findings signal a need for intervention, apart from ergonomics parameters various psychosocial workplace factors need to be considered while designing a preventive intervention program, including training and education on posture, prior to entry into the workforce. Students are future workers therefore it is important to determine whether their increasing exposure to computers, prior to entering the workforce may make them already injured or do not enter their chosen profession due to upper extremity musculoskeletal discomfort. The future health of undergraduate students deserves consideration, therefore more research is needed on this matter.

Keyword: computer risk factors; computer user; upper extremity musculoskeletal discomfort

ABSTRAK

Kajian mengenai masalah ketidakselesaan pada anggota atas berkaitan dengan penggunaan komputer dalam kalangan pelajar kolej adalah terhad walaupun risiko pendedahan mungkin sama dengan pekerja profesional. Penggunaan komputer yang meningkat dalam kalangan pelajar kolej menyebabkan peningkatan gejala muskuloskeletal. Bukti menunjukkan bahawa gejala tersebut dapat dikurangkan melalui kaedah ergonomik dan pendidikan. Ulasan dari penyelidikan yang lalu mendapati bahawa faktor risiko yang berkaitan dengan penggunaan komputer adalah seperti postur tubuh, jangkamasa penggunaan komputer, faktor psikososial, persekitaran kerja seperti ruang kerja dan keadaan sekeliling serta aduan dan sejarah masalah ketidakselesaan pada anggota atas. Hubungkait di antara faktor risiko tersebut dan masalah ketidakselesaan pada anggota atas ditentukan dalam kajian ini. Dengan kata lain, tujuan kajian ini adalah untuk menyiasat sama ada faktor risiko yang ada di kalangan pelajar kolej boleh menyebabkan masalah ketidakselesaan pada anggota atas. Untuk tujuan ini, kajian keratan rentas korelasi telah dilakukan untuk memastikan hubungkaitnya. Sebanyak 132 soalselidik telah diedarkan kepada para responden dan hanya 130 (98.5%) soalselidik dikembalikan semula. Hipotesis penyelidikan telah diuji menggunakan Analisis Korelasi Pearson. Didapati postur tubuh, faktor psikososial, sejarah gejala ketidakselesaan pada anggota atas mempunyai hubungan yang positif terhadap gejala ketidakselesaan pada anggota atas. Namun demikian, jangkamasa rehat dari menggunakan komputer dan persekitaran kerja menunjukkan hubungan yang sebaliknya. Ujian Regresi Berganda menunjukkan 35.8% variasi yang terdapat dalam kajian ini telah berjaya dijelaskan oleh enam faktor risiko yang terlibat di dalam kajian ini. Keputusan kajian ini menunjukkan bahawa perlunya ada intervensi selain dari ergonomik, pelbagai faktor psikososial di tempat kerja yang harus dipertimbangkan semasa merangka program intervensi pencegahan. Ini termasuklah latihan dan pendidikan yang seharusnya diberikan sebelum melibatkan diri dalam dunia pekerjaan. Pelajar adalah pekerja kita di masa hadapan, oleh itu penting bagi kita menentukan sama ada peningkatan pendedahan terhadap komputer di kolej atau universiti akan menyebabkan mereka mengalami gejala ketidakselesaan pada anggota atas sebelum menyertai dunia pekerjaan. Akibat dari gejala yang dialami, mereka mungkin tidak dapat memilih kerjaya mereka lantaran dari masalah gejala ketidakselesaan pada anggota atas. Masa hadapan kesihatan pelajar memerlukan perhatian sewajarnya. Maka diharapkan lebih banyak pihak membuat penyelidikan berhubung dengan isu ini di masa hadapan.

Kata kunci: faktor risiko komputer; pengguna komputer; gejala ketidakselesaan pada anggota atas

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LIST OF ABBREVIATIONS

NIOSH	National Institute of Occupational Safety and Health
MSDs	Musculoskeletal Disorders
MSK	Musculoskeletal
NADOPOD	Notification of Accident, Dangerous Occurrence, Poisoning and Occupational Disease
OSHA	Occupational Safety and Health Act
SHC	Safety and Health Committee
SHO	Safety and Health Officer
SOCSO	Social Security Organization
UED	Upper Extremity Disorders
U.S	United States
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Computer issues

Computers have become ubiquitous in every home and workplace in today's world. According to U.S Census Bureau (2005), in 2003 itself there were 70 million American households which had more than one computer. This number is an increase from 56% in 2001 to 62% in 2003. Over the years, computer based technology has caused work intensity to increase and created a stressful and unhealthy working condition, inadvertently contributing to an increase in work-related musculoskeletal disorders (WMSDs). Interestingly, computer-related musculoskeletal disorders contribute to a significant public health burden and accounted for one-third of lost work days in 2006 (Bureau of Labor Statistic, 2008).

Generally, it is undeniable that computers help to improve and increase productivity, however, there are many significant adverse effects on musculoskeletal system due to extensive computer use as reported by Wilkens (2003). Work-related musculoskeletal disorders (WMSDs) encompass a spectrum of musculoskeletal injuries that are related to work (Green, 2008). WMSDs are a group of painful disorders of muscles, tendons, and nerves. Carpal tunnel syndrome, tendonitis, thoracic outlet syndrome, and tension neck syndrome are examples. Work activities which are frequent and repetitive, or activities with awkward postures cause these disorders which may be painful during work or at rest.

Almost all work requires the use of the arms and hands. Therefore, most WMSD affect the hands, wrists, elbows, neck, and shoulders. Work using the legs can lead to WMSD of the legs, hips, ankles, and feet. Some back problems also result from repetitive activities. Walker Bone, Palmer, Reading, Coggon & Cooper (2004) pointed out that upper limb pain was very common in general population, with 36% of men and women in Britain reporting pain within the upper extremities in any given week.

Musculoskeletal pain is a significant issue worldwide as it contributes to various type of disability and more importantly the economic cost incurred. In 2009, Côté et al. study showed the annual prevalence of neck pain ranges from 27.1% in Norway to 47.8% in Quebec and the annual prevalence of neck pain interfering with daily activities is 14.1% in Canada's general population of workers.

In recent study conducted by Denis, St-Vincent, Imbeau, Jette, & Nastasia (2008), MSDs had incurred exorbitant cost in United States and Quebec, Canada. They stated that in year 2000 alone, USD 45-54 billion and CAD 500 million was spent respectively on MSDs. In view of high prevalence compounded by tremendous economic cost clearly indicate that these worldwide issues require much more attention.

In the era of globalisation, service industry has opted to move towards computer based tasks and daily computer use (Cagnie et al., 2007). However, as a consequence of continuing development of information technology and a shift towards service sector oriented employment, it has increased the incidence and prevalence of neck pain (Côté et al., 2009). The rise in MSDs may be attributed to an increase in sedentary work as well as occupational and recreational computer use. Côté et al.

(2009) reported that one year prevalence of neck pain ranges from 17.7% to 63% among office workers across different countries.

Today's education either secondary or tertiary has incorporated computer in their learning process as the students can retrieve relevant information pertaining to their subjects learned. Therefore, some educational institutions have focussed on technology enhanced learning and skill acquisition and included lap-top based education to prepare students for the workplace in future (Gray, 2011). In 2007, the usage of notebook computer by university students has raised from 52.8% in 2005 to 75.8% (Jacobs et al., 2009). The drastic increased in laptop computer users has indeed associated with possible increase in the development of MSDs. Extensive study has been performed on desktop computer and work-related MSDs which showed a significant associations, the reporting of MSDs symptoms were increased. However, only minimal study was done on student populations. This is surprising as study has shown that students report statistically more frequent musculoskeletal discomfort compared to professionals in the region of upper extremity and back (Cooper, Sommerich & Mirka, 2004). According to Katz et al. (2000), 41% of university students reported experiencing musculoskeletal pain while using computer. Schlossberg et al. (2004) reported that musculoskeletal symptoms were associated with computing in graduate engineering students at a college campus in the Western United States. Graduate students represent a transitional period between working and education, they are future workforce and they should be healthy as they are valuable asset for the every country.

However in this study, no differentiation between desktop and laptop computers use are made although there are obvious differences between the way a desktop and laptop computer are used. For instance, desktop workstations are adjustable and used largely by workers in the office whereas laptop computers are used by students in crowded lecture halls where the seats and desks height cannot be adjusted. Furthermore, students laptop users in general do not use the key board, mouse and monitor as compared to desktop computer. In view of this, laptop users are vulnerable to postural stress.

Katz et al. (2000) mentioned that university students population are potentially at risk for developing neck and upper limb pain. Since the usage of laptops has grown exponentially by university students, therefore it is crucial to evaluate the potential risks of developing MSDs in relation to laptop use so that appropriate prevention and control measures could be taken to minimise the risks. Prolonged computer used also predisposed students to fatigue, eye strain and mood disturbances other than MSDs (Galinsky, Swanson, Sauter, Dunkin, Hurrel & Schleifer, 2007)

1.2 Information about college

Institute Megatech College of Technology

Institute Megatech was established in November 1987 under the name of Pusat Bimbangan Mega Sdn Bhd. Initially the college was set up as a tuition centre to provide academic support for the following professional examinations:

1. Engineering Council Examination, UK – Parts I & II
2. Institution of Engineers Malaysia – Parts I & II
3. City & Guilds of London Institute, UK – Parts I,II & III

As the number of students started to grow gradually, the Directors of the college saw the need to establish a full time college to cater to the needs of the Industries which were facing shortage of skilled man power.

Hence, in October 1988 Institute Megatech was formally established as a specialist college providing Certificate, Diploma and Higher Diploma courses in Electrical & Electronic Engineering. Courses were conducted both full-time and part-time to cater for the needs of fresh school leavers and working adults.

From its humble beginning, Institute Megatech has since developed and matured into a dynamic and vibrant full-fledged Engineering college which has pioneered the following educational achievements in Malaysia:-

In 1991 for the first time a consortium of private colleges was formed in Malaysia to offer the then BTEC HND programmes. Institute Megatech takes pride to be one of the member colleges of this consortium. The HND programme created a pathway for successful Malaysian students to complete their degree in less than ONE year in a UK University thus creating the famous '2+1' Degree concept within the Malaysian education scenario.

Since its inception, Institute Megatech has been one of the few colleges which prepared students for the professional examinations offered by the Engineering Council (UK) and The Institution of Engineers Malaysia. Many professional engineers in industry have benefited out of it excellent performance record.

Institute Megatech was among the first to become a C&G examination centre in Malaysia thus enabling candidates to sit for the world renowned City & Guilds examination in Malaysia.

In 1994, Megatech became one of the first few private colleges to offer skills courses in the field of Industrial Electronics, Computing, Information technology and Mechatronics. These skills courses were offered in collaboration with the Majlis Latihan Vokasional Kebangsaan, under the Ministry of Human Resources, Malaysia.

Institute Megatech was also one of the first few private colleges to offer tailor made in house technical training programs under its Corporate Training Division to multinational companies such as Motorola, National Semiconductor, Western Digital and many other manufacturing conglomerates in the field of Electronics. Currently, the institute has about 200 students doing various courses offered to them.

1.3 Background of the study

As mention earlier, in today's fast-paced society, computers have virtually extensively used by Malaysian population, including office workers and students, as a consequences musculoskeletal disorders are becoming more prevalent among computer users (Zakerian & Subramaniam, 2011). According to National Institute of Occupational Safety and Health (NIOSH) Malaysia, it stated that 61.4% of the Malaysian's workforce use computer at work (Lee, 2006). This is attributed to increasing use of advanced technology in the workplace, thus computer is portrayed as an essential feature in one's daily life. A large number of research studies indicate that computer users are susceptible to experiencing musculoskeletal discomfort (Carayon, Haims, Hoonakker & Swanson, 2006; Jensen, Rhyholt, Burr, Villadsen & Christensen, 2002; Marcus & Gerr, 1996).

Social Security Organization (SOCSO) Malaysia reported that the number of cases involving injuries which are musculoskeletal in nature was at alarming rate of 10,000 per year (Lee, 2006). This is definitely affects a majority of workers in Malaysia (Zakerian & Subramaniam, 2011). World Health Organization (WHO) characterizes "work-related" disorders as multifarious which means that a variety of risk factors like physique, psychosocial, work organization and sociological risks influencing such disorders. Dandannavar and Goudar (2010) pointed out that coordinated movement and skilled activities of the upper limbs are fundamental in regular computer users, as a result to this the users will develop musculoskeletal disorders namely upper limb, neck and shoulders. They mentioned that the important risk factors are long period of uninterrupted work and holding same posture without a break is the setback of working at a computer.

Study by Côté et al. in 2009 found that the rising use of information technology together with the increases in service sector oriented employment have coincided with recent increases in the incident and prevalence of neck pain. A steady increase in the service sector industry has been observed within Canada, representing 78% of employment within Canada (Industry Canada, 2009). As a consequences of such a prevalent demand for competent service workers, comes the natural requirement toward the use of computer technology. As a matter of fact, way back in 1992, the service sector industry was one of the top five largest purchasers of computers (Triplett & Bosworth, 2001).

The rise in the incidence and prevalent of neck pain or other MSDs may be partly influenced by an increase in sedentary work as well as occupational and recreational computer use. Study conducted by Cagnie et al. (2007) demonstrated 12-month prevalence of neck pain of 45.5% in office workers. Recent study by Côté et al. (2009) report also shown that one year prevalence of neck pain ranges from 17.7% to 63% in office workers across different countries. Due to current demand for technology based skills in service sector, some secondary and tertiary education institutions have developed technology enhanced learning programs. In this circumstances, students need to have their personal computer either laptop or desktop. Selected institutions may provide their students with laptops. Jacobs et al. (2009) found that laptop computer use was on rise as evidence by increment in percentage used by students from 52.8% in 2005 to 75.8% in 2007. Another study done by Smith et al. (2009) indicates that there is an increase in laptop ownership from 66% in 2006 to 88% in 2009.

In view of computer may poses significant MSDs risk factor in young generation about to embark on their working life, therefore it is imperative to develop measures to assess the ways in which computer are being used by students and in what way it relates to the known risk factors for MSDs (Gray, 2011). The need is strongly supported by the prominent increase in the use and ownership of laptop computers among students.

Extensive research being conducted on computer and work related MSDs which have found associations between desktop computer use and increase risk of reporting MSDs (Gray, 2011). Nevertheless, a limited number of researches have concentrated on computer-use- related MSDs in university or college students even though the risk factors may be similar to workers who use computers. Generally, students report more frequent upper extremities discomfort than the professionals (Noack-Cooper, Sommerich & Mirka, 2009). These students reported that they have uninterrupted work behaviours than professional. They use computer at least 18 out of 24 hour/day, compared to 12 hour for professionals. Frequent assumption was due to awkward postures that cause the discomfort.

The findings highlighted the necessity for intervention, including training and education, prior to entry to workforce as suggested by Noack-Cooper, Sommerich & Mirka, (2009). Students are future workforce, therefore it is crucial to determine whether their increasing exposure to computers prior to entering the workforce will make them more vulnerable to MSDs later. One study done by Katz et al. (2000) in a population of university students found that 41% of the participants reported experiencing musculoskeletal pain when using a computer.

In student population, the magnitude of risk factors are amplified due to the nature of their work environment. Most of the time lecture halls and campus study rooms or learning suites are characterized by fixed furniture which ergonomically unfriendly. Students are not able to adjust either desk or chair height. Therefore, instead of the furniture adapt to students of varying height and body type, the students need to adjust their postures to suit the environment. Sadly to say, usually they have awkward body postures. Lecture halls and campus study rooms or learning suites also have restricted space, unlike home or dormitory settings that have the potential for workspace modification. This clearly shown that the education institutions environment enhance the probability of exposure to certain risk factors for musculoskeletal discomforts. Indeed, the relationship between MSDs and computer use should be completely understood in order to implement appropriate measures to be taken to reduce the risks of MSDs and the consequences.

This study aims to determine the relationship between risk factors of computer use and upper extremities discomfort among university or college students. It is an interesting issue to study as there is very limited study about MSDs among university or college students. Much research has been done pertaining to MSDs among office workers. Ironically, studies have shown that students report more frequent musculoskeletal discomfort than professional in the region of upper extremities and back (Cooper, Sommerich & Mirke, 2004).

1.4 Problem Statement

Computer technology plays an essential role in students' academic, personal and social lives. Information technology make them feel globally connected, feeling of being efficient as technology simplified their tasks and increase accessibility. Despite the advancement in this technology, it has the drawbacks. Students believed that physical symptoms that they experienced , such as neck pain, back-ache, wrist pain, etc. were due to long duration of use and uncomfortable or awkward postures (Gustaffson, Dellve, Edlund & Hagberg, 2003).

In a study conducted by Gemmill and Peterson (2006), 97.3% students participants had a personal computer. Even with such high prevalence of technology used among college students, minimally is known about MSDs in this population. Generally we can say that today's college students are exposed or at risk of developing MSDs discomfort or and pain due to they spend much of their time in static sitting positions, either in classes or while working on the computer. To make the condition worse, the non-ergonomically workstation in a university increase the likelihood of upper extremity pain. Hupert, Amick, Fossel, Coley, Robertson and Katz (2004) found that more than half of surveyed college students reported upper extremity pain or discomfort when using the computer.

According to Katz et al. (2000) and Hupert et al. (2004), in 2017, there will be 20.1 million students enrolled in degree-granting institutions and from this figure, 10 million college students may experience MSDs symptoms after computer use. A study by Jenkins, Menendez, Amick, Tuller, Hupert, Robertson et al. (2007) reported that the regions with the highest prevalence of pain were the neck (72%), shoulder (56%) and wrist (51%). Another study conducted by Schlossberg, Morrow, Llosa, Mamary, Dietrich and Rempel (2004) among engineering graduate students and found that 60% of them reported persistent or recurrent upper extremity or neck pain related to computer use.

Cooper et al. (2004) found that college students have been found to use their computer an average of 33.7 hours per week and usually in the evening. In future, as college students are entering technology-intensive occupations following graduation, MSDs and functional limitation may have significant impact on students' professional career plans and productivity. The compounding effect of the widespread use of computer among students and the potential severity as well as high cost of MSDs associated with their use, pose crucial public health implications. Hence, there is a need for extensive research on this matter and also development and implementation of interventions that result in decreased risk.

1.5 Research Questions

In the process of evaluating the relationship between the risk factors of computer usage and musculoskeletal discomfort (upper extremity) among university student, a few questions have been raised in the beginning of the research.

The questions are as the following:

1. Do body postures associated with musculoskeletal discomfort (upper extremities symptoms) among university students?
2. Does break time of computer use associated with musculoskeletal discomfort (upper extremities symptoms) among university students?
3. Do psychosocial factors (job control, job demand, social support) associated with musculoskeletal discomfort (upper extremities symptoms) among university students?

4. Does work environment (workstation and study environment) associated with musculoskeletal discomfort (upper extremities symptoms) among university students?
5. Does history of musculoskeletal pain associated with musculoskeletal discomfort (upper extremities symptoms) among university students ?
6. Do body region complaints associated with musculoskeletal discomfort (upper extremities symptoms) among university students?
7. Do the factors (body postures, break time, psychosocial factors, work environment, history of musculoskeletal pain and body region complaints) influence musculoskeletal discomfort (upper extremities symptoms) among university students.

1.6 Research Objectives

1.6.1 General Research Objective

Given the importance of knowing this problem, the current study aims to investigate risks factors associated with computer use and their relationship or correlation with musculoskeletal discomfort (upper extremities symptoms) among university students.

This study is to determine the factors that are positively attributed to the prevalence of musculoskeletal discomfort (upper extremities symptoms) among university students who use computer constantly every day, either for specific tasks or personal administration or leisure.

1.6.2 Specific Research Objectives

1. To examine the relationship between body postures and upper extremities musculoskeletal discomfort among university students.
2. To examine the relationship between break time of computer use and upper extremities musculoskeletal discomfort among university students.
3. To examine the relationship between psychosocial factors (job control, job demand, social support) and upper extremities musculoskeletal discomfort among university students.
4. To examine the relationship between work environment (workstation and study environment) and upper extremities musculoskeletal discomfort among university students.
5. To examine the relationship between history of upper extremities musculoskeletal symptoms and upper extremities musculoskeletal discomfort among university students.
6. To examine the relationship between body region complaints and upper extremities musculoskeletal discomfort among university students.
7. To examine the factors (body postures, break time, psychosocial factors, work environment, history of musculoskeletal pain and body region complaints) that influence upper extremities musculoskeletal discomfort among university students.

1.7 The scope of the study

The study is conducted amongst students at Institute Megatech College of Technology. The intention is to evaluate the prevalence of upper extremity discomfort related to computer use among students in this college. Majority of the students possess their own computer to perform their assignments and searching for information as well as for recreational use. The success of the study depends on the participation from the students and management cooperation during data collection process. The college is chosen because the students are relatively small number as compared to other colleges or universities, therefore it is relatively easy to track the respondents and more importantly majority of the students used and owned a computer. Therefore, it makes the students a good population for this study.

1.8 Significant of the study

This study enhances the level of awareness among students, Institute Megatech management and government regarding computer ergonomics factors which contribute to musculoskeletal disorders. The consequences are significantly impacting the individual, organizations and government in terms of productivity and physical and mental well-being. The cost of ignoring ergonomics hazards is high. The direct cost may involve medical treatment for doctor's visit, therapy and eventually surgery. The indirect cost is the most important as it affects future workforce, country's productivity and expenses towards ergonomics issues in our population. Hence, this issue requires more attention and further research in this area.

1.9 Summary and organization of the thesis

This study aims to determine the risks factors associated with computer use and their relationship with musculoskeletal discomfort (upper extremities symptoms) among college students. It is an interesting issue to study as there is very limited study about musculoskeletal discomfort among college students. Much research has been done pertaining to musculoskeletal discomfort among office workers. Ironically, studies have shown that students report more frequent musculoskeletal discomfort than professional in the region of upper extremities and back (Cooper, Sommerich & Mirke, 2004). This chapter discuses on research problem, research questions, research objectives and the scope of the study related to risks factors associated with computer use and their relationship or correlation with musculoskeletal discomfort (upper extremities symptoms) among university students.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the literature review related to research topics. This study is carried out based on previous study on upper extremity musculoskeletal discomfort related to computer use among university students.

2.2 Health and Safety Legislation

There is no specific act, regulation or guideline available concerning ergonomics implementation. Ergonomics under Occupational Safety and Health Act (OSHA) 1994 is referred to direct and indirect statements (refer Table 1) and the contents are in the main, more directed towards management issues. For example, in objective Section 4(c) OSHA 1994 such as, "to promote an occupational environment for persons at work which is adapted to their physiological and psychological needs". Even though the statement does not mention ergonomics directly, "physiological and psychological" refers to ergonomics. Other explanation as stated in Table 2.1.

Table 2.1

Ergonomics Mention in Act and Regulation.

Issue	Detail in the category (FMA/OSHA)	Act or regulations relevant to ergonomics (summary)	Comments
Objectives of OSHA	Sec.4 OSH Act 1994	The objectives of OSHA: - To promote an occupational environment for person at work which is adapted to their physiological and psychological needs.	Direct and strong relations between ergonomics and the OSH objectives.
Safety and health (S&H) policy	Sec.16 OSH Act 1994	……..to prepare…………a written statement of general policy with respect to the safety and health at work.	Indirect but strong relations between ergonomics and S&H policy. It is more towards awareness of employer to set a safety policy with ergonomics emphasis.
Medical Surveillance	Sec.28 OSH Act 1994	…by reason of changes in any process…there may be risk or injury to the health of persons employed in the process.	Indirect and strong relations. Ergonomics fails within one of the safety and health scope. Need to establish a base against which changes in health care status can be evaluated [14]
Functions of SHO	Sec.15 OSH Act Reg.(18) Safety and Health Officer under OSHA 1994	…duty extends include in particular: a) Provisions and maintenance of plant… b) Making arrangement… …to investigate new miss…to collect, analyse and maintain statistics on any accident	the ergonomics has too much uncertainty [15].Thus, SHO difficult to collect, analyse data and to measure the risk without any strong knowledge and expertise.
Functions of safety and health committee (SHC)	Sec.31 OSH Act 1994 Reg (11d) Safety and Health Committee Regulation 1996 under OSHA 1994	The SHC shall keep under review the measures taken…….which a member of the committee or a person employed thereat considers it not safe or is a risk to health. …review safety and health policies at the workplace and make recommendations to the employer for any revisions of such policies. ....inspect workplace every 3 months... ...inspect accident...review OSH report	Indirect but strong relation between ergonomics and function of SHC. Ergonomics falls within one the safety and health scope. However, in order to conduct the SHC on ergonomic aspect is still not clear except for those who involved in accident, or for large companies, which have their own consultant to conduct the committee.

continued			
Responsibility of notifications	Reg.(&) NADOPOD 2004 under OSHA 1994	An employer shall send a report in an approved form to DOSH within 7 days where a person at work suffers from one of the occupational poisonings or occupational diseases in the 3rd schedule.	Indirect but strong relation between ergonomics and responsibility in making notification. 3rd schedule mentioned in the NAPOPOD: (under OSHA 1994), heat cramp / heat stroke, inflammation of synovial lining of the wrist joint and tendon sheath, cramp of the hand or forearm due to repetitive movements, hearing impairment caused by noise, diseases caused by vibration. Difficult to identify at the early stage.

Source: Proceeding of the 2011 International Conference on Engineering and Operations Management Kuala Lumpur, Malaysia 22 – 24, 2011 (Md Sirat, Shaharoun, & Syed Hassan, 2011)

2.3 Theory on musculoskeletal disorders

Based on the scientific evidence in published literature about precipitation of musculoskeletal injuries in the workplace, four theories have been proposed to explain these afflictions. Central to all theories is the presupposition that all occupational musculoskeletal injuries are biomechanical in nature. Disruption of mechanical order of a biological system is dependent on the individual components and their mechanical properties. These common denominators will be causally affected by the individual's genetic endowment, morphological characteristics and psychosocial makeup, and by the occupational biomechanical hazards. This phenomenon is explained by the Multivariate Interaction Theory.

Differential Fatigue Theory accounts for unbalanced and asymmetric occupational activities create differential fatigue and thereby a kinetic and kinematic imbalance resulting in injury precipitation. Cumulative Load Theory suggests a threshold range of load and repetition product beyond which injury precipitates, as all material substances have a finite life.

Finally, Overexertion Theory claims that exertion exceeding the tolerance limit precipitates occupational musculoskeletal injury. It is also suggested that while these theories may explain the immediate mechanism of precipitation of injuries, they all operate simultaneously and interact to modulate injuries to varying degrees in different cases. All the theories are by Kumar (2001).

2.4 Review of Previous Research Study

2.4.1 Musculoskeletal disorders

Musculoskeletal disorders (MSDs) have been defined by Bureau of Labor Statistic (2008) as “injuries or illnesses affecting the connective tissues of the body such as muscles, nerves, tendons, joints, cartilage or spinal disc”. It is also known as cumulative trauma disorders (CTDs), repetitive overuse disorders, repetitive motion disorders, repetitive strain disorders or injuries, overuse syndromes or injuries (Foye, Cianca & Prather, 2002). Though MSDs have various terms, but it virtually refer to similar problem which is caused by factors that exert mechanical stresses on them in a repetitive, prolonged or forceful manner, resulting in trauma or injury (Kumar, 2001).

The concepts were supported by Sommerich, Maras & Karwowski (2006), they mentioned that human body needs sufficient intervals of rest between episodes of strain to repair itself, therefore a person would be subjected to a higher risk for developing MSDs if such recovery time were inadequate and/or high repetitive of forceful and awkward postures were present. Research findings by Bernard, Sauter, Peterson, Fine & Hales (1993) indicated that majority of participants in their study had reported a decrease in hand/wrist symptoms after being on vacation for more than one week.

Generally, upper extremity MSDs are disorders that affect the upper back, neck, shoulders, arms, wrists and fingers. The symptoms, among others, are pain, aching, soreness, weakness tingling sensation and numbness during use of the extremities (Hamilton, Jacobs & Orsmond, 2005). A large number of musculoskeletal discomfort resolved by rest and usually short-term, but the chronic disability will develop after prolonged repeated exposure to the insults as mentioned by Carter & Banister (1994). MSDs have no predilection over body parts that are affected, however several studies done reported that neck is the most common site affected (Bernard, Sauter, Peterson, Fine & Hales, 1993; Jensen, 2003). Other studies have found that shoulder was the most frequently affected (Smith, Sato, Miyajami, Mizutani & Yamagata, 2003).

Numerous researches done in this field focused specifically on work-related MSDs in various occupations. These disorders are attributed to work when work activities and work conditions significantly contribute to their development and exacerbation, however are not the sole determinant of causation (Buckle & Devereux, 2002). Interesting report by Bureau of Labor Statistic (BLS) in 2008 indicates that 335,390 MSDs occurred in 2007 across all occupations and they required a median of nine days away from work. When comparing with nonfatal injury and illnesses in 2001, MSDs cases prone to have higher percentage of long-term work loss. NIOSH (2004) reported that 23.9% of MSDs cases have 31 or more days of loss work.

As mention earlier, MSDs occur in all industries and occupations but more prevalent in services, manufacturing and retail trade sectors (NIOSH, 2004). As for occupation that requires extensive computer use, data entry clerks had MSDs incidence rate of 65.6 cases per 10,000 workers requiring a median of 24 days away from work (Bureau of Labor Statistic, 2008). Sommerich et al. (2006) pointed out that carpal tunnel syndrome (Figure 2-1), neck tension syndrome and thoracic outlet syndrome (Figure 2-2) as well as De Quervain's Tenosynovitis (Figure 2-3) were specifically associated with typing and keying, while cubital tunnel syndrome was associated with "resting forearm near elbow on a hard surface and/or sharp edge", a frequent phenomenon in typing. In terms of median lost work days, carpal tunnel syndrome - 28 days, the longest (Bureau of Labor Statistic, 2008).

MSDs are not unique to the American work force only, in fact Buckle & Devereux (2002) estimated that in U. K., 5.4 million working days are lost annually due to time off work as a result of upper extremity MSDs approximately 1 month work is lost annually for each individual case. MSDs resulting in high number of lost workdays due to these disorders involved severe pain leading to restricted physical activity and therefore high absent rate from work and potential high employee turnover. Moreover, MSDs lead to high compensation and healthcare expenses. The total costs associated with work-related musculoskeletal disorders are estimated to be as high as $100 billion annually (Waters & MacDonald, 2001).

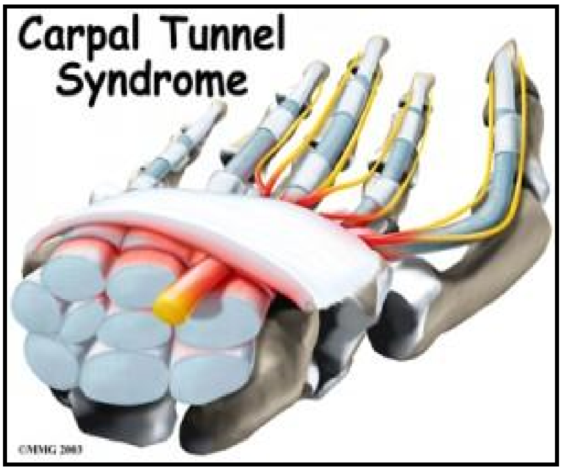

Figure 2-1.
Carpal Tunnel Syndrome (Health and Fitness 101, 2010)

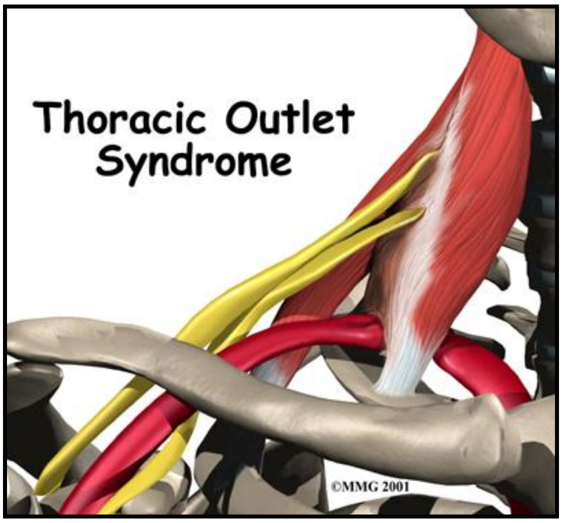

Figure 2-2 .
Thoracic outlet Syndrome (Health and Fitness101, 2010)

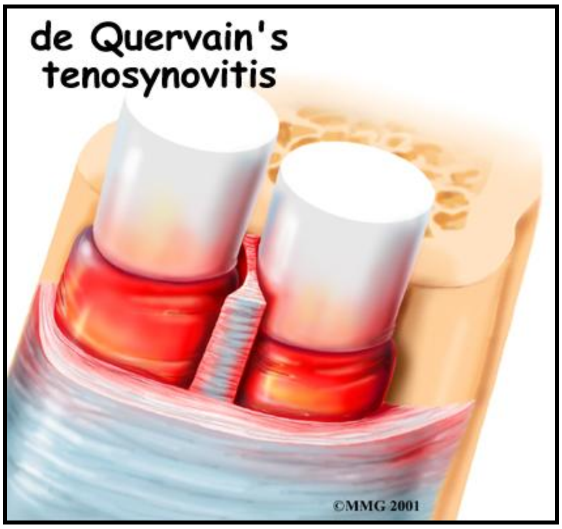

Figure 2-3.
De Quervain’s Tenosynovitis (Health and Fitness 101, 2010)

2.4.2 Risk Factors for MSDs Related to Computer Work

MSDs are considered multi-factorial, as physical, psychological, environmental and individual characteristic influenced musculoskeletal discomfort (Sommerich et al. 2006). Study by Halperm and Davis (1993) has examined the relationship between MSDs and ergonomics risk factors such as computer workstation design, monitor, keyboard and mouse placement. They found positive relationship where participants reported minor or moderate pain in at least one body part. Shuval and Dolchin (2005) found that those participants who were uncomfortable at their work stations reported increased discomfort in the neck and shoulder. Study by Blatter and Bongers examined the duration of computer work and MSDs and found that prolonged repetitive or forceful movements can cause pressure on the connective tissue of the upper extremity. This is eventually lead to MSDs.

2.4.2.1 Work environment

Halpern and Davis (1993) pointed out that poor workstation design and layout are common where 64% of the sample rated at least one aspect of the workstation was poor. They also reported that 57% of those participants who responded to the survey experienced minor or moderate pain in at least one body part. In other study , sample dissatisfaction with their workstation layout was associated with prolonged neck pain (Andersen, Harhoff, Grimstrup, Vilstrup, Lassen, Brandt et al., 2008) and with elevated risk for carpal tunnel syndrome (Andersen, Thomsen, Overgaard, Lassen, Brandt, Vilstrup et al., 2003). Poor placement of both keyboard and mouse also increased risk for pain in upper extremities, shoulders and neck in the study done by Sillanpa, Huikko, Nyberg, Kivi, Laippala and Uitti (2003). They also found that employees' perception that their workstations were not ergonomically set-up was strongly associated with increased prevalence in musculoskeletal discomfort.

2.4.2.2 Body Posture

Poor postures usually due to the task being performed and from poor ergonomic design of computer workstation. Classical example, while typing on the keyboard, the parallel position of the rows requires and inward rotation (pronation) of the forearms and wrists and a sideways bend (ulna deviation). As a result of this awkward position, the pressure in the carpal tunnel increase which later increase the risks of Carpal Tunnel Syndrome (CTS) (Faragasanu & Kumar, 2003). If the workstation is poorly design, the workers may need to tilt their neck in order to see the computer screen. Ones may need to bend his/her trunk forward if the screen is far away. Keyboard that is too high, too low or too far away causes the workers to elevate their shoulders. Straker, Pollock and Mangharam (1997) stated that workers reported greater discomfort and fatigue when the shoulders were at 30 degree flexion as compared to 0 degree shoulders flexion posture. Awkward posture among mouse computer users has been associated with increase reporting of MSDs symptoms (Faragasanu & Kumar, 2003). Blatter and Bongers (2002) found that prolonged static posture was noted to have the strongest influence on MSD incidence.

The pictures as in figure 2-4 show examples of tasks involving low – medium level stress which could result in cumulative MSDs:

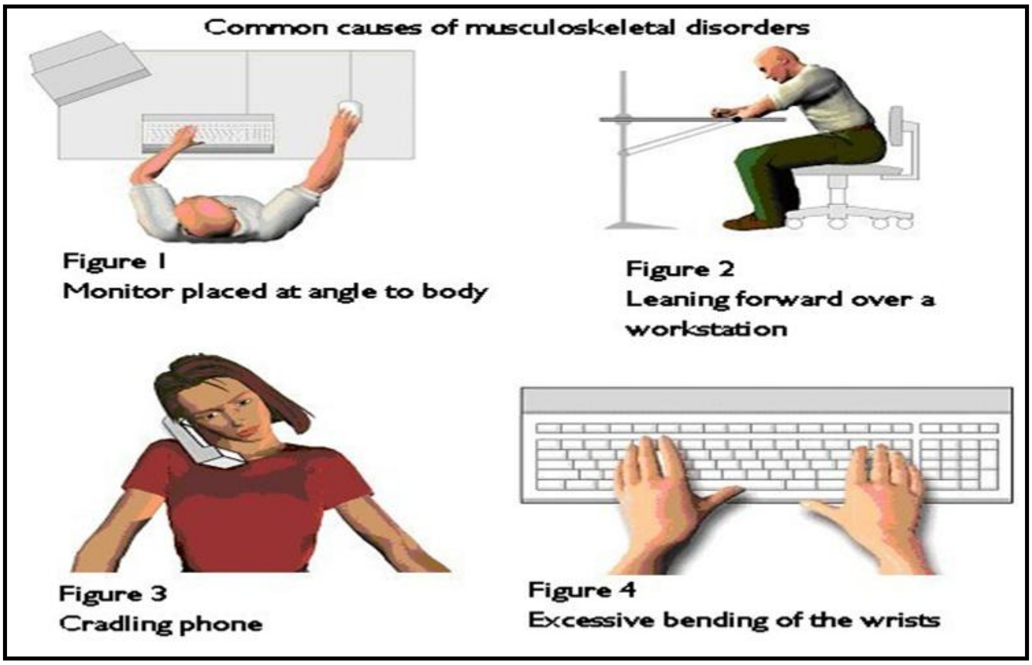

Figure 2-4.
Common causes of musculoskeletal disorders (Systemconcept, 2006)

Figure 1

Monitor placed at angle to body results in rotation of cervical spine, causing sustained muscle contraction on one side and prolonged stretch of tissues on the other.

Figure 2

Leaning forward over a workstation causes prolonged bending of the neck, loss of lumbar curvature and shoulders to be pulled forward which can contribute to neck, low back and upper limb conditions.

Figure 3

Cradling the phone between shoulder and ear places considerable stress on the musculature of the neck and shoulders. Prolonged muscle contraction can reduce blood flow and increase likelihood of trauma.

Figure 4

Excessive bending sideways of the wrists during typing away from a neutral, straight line demands considerable muscle action over prolonged periods which can irritate tendons, muscles and connective tissue.

Chronic, cumulative MSDs are easier to prevent than they are to treat. How can we tackle these silent conditions before symptoms arise? The key here is in prevention through effective risk assessment. Using the evidence available regarding factors which increase the risk of MSD development, systematic analysis of activities should be carried out and appropriate measures taken to eliminate or reduce this risk. It is crucial to be proactive in this approach, taking positive action to identify risks present, not waiting for symptoms to arise to sound those warning bells. By this time, much of the damage is already done.

2.4.2.3 Break time of computer usage

Several studies according to Gerr, Marcus and Monteilh (2004), Gerr, Monteilh and Marcus (2006) and Village, Rempel & Teschke (2005) found positive relationship between duration of computer usage and MSDs: increase hours of computer work are associated with increased MSDs prevalence in all parts of the body. It is very clear why it is so often found in the research – the longer a person spends time working in computer, lesser break time, the longer he/she is maintaining awkward postures and performing repetitive motions, which eventually lead to pain and discomfort in upper extremities. A cross-sectional questionnaire study by Blatter and Bongers (2002) found that those who work with computer more than 6 hours per day was associated with upper extremities MSDs in all body regions in men and women.

According to Carter and Banister (1994), typing often requires uninterrupted, relatively forceful and fast striking of the keys, static loading and uncomfortable position of the arms, hands and wrists, exposing the computer operator to an increase risk of overuse injury. Another study by Andersen, Haahr and Frost (2007) found that highly repetitive work predicted arm pain in a large sample of workers from 39 different places. Jensen (2003) also found that high degree of repetitiveness, among other variables, was a risk factor for the development of musculoskeletal symptoms among female workers. Palmer, Harris and Coggon (2007) in their literature review concluded that there is substantial evidence that prolonged and highly repetitive flexion and extension of the wrist significantly increases the risk of CTS, especially when couple with forceful grip.

In Sweden, Fredriksson, Alfredsson, Ahlberg, Josephson, Kilbom, Wigaeus et al. (2002) conducted a population-based case-control study, pointed out that increase amount of computer work was associated with neck and shoulder pain and discomfort. However, study performed by Jensen (2003) found that duration of computer work was associated with hand-wrist symptoms, but not with neck symptoms. A review done by Ijmker, Huysmans, Blatter, Van der Beek, Van Mechelen & Bongers (2007) found similar findings. They mentioned that the duration of computer mouse use was strongly and consistently associated with the incidence of hand-arm symptoms than the duration of total computer and keyboard use. Andersen et al. (2003) study found an association between mouse use for more than 20 hours per week and risk of carpal tunnel syndrome.

2.4.2.4 Psychosocial factors

Several number of studies reported relationship between upper extremities MSDs and various psychosocial and job related factors. For instance, employees who face frequent deadlines and high psychological demands have low skill discretion and social support and spent more time keyboarding were more likely to report moderate to severe MSDs symptoms (Polanyi, Cole, Beaton, Chung, Wells, Abdollel et al., 1997). Karlqvist et al. (2002) found that time pressure was associated with high prevalence of symptoms among female participants. Low job satisfaction predicted neck/shoulder pain and lower limb pain by participants in the study done by Andersen et al. 2007. The addition of mental demands during computer work caused an increase in the musculoskeletal activity and eventually results in overexertion and discomfort of muscles (Laursen, Jensen, Garde & Jorgensen, 2002).

There has been substantial evidence surrounding the effects of job strain (job demand and control) on health. Côté et al. (2009) found evidence suggested that high amounts of job demand and low job control can increase the risk and incidence of neck pain. Although job strain may not be an issue for student's population, there has been evidence that psychosocial factors such as stress do have an impact among students. Findings by Niemi, Levoska, Rekola and Keinanen-Kiukaanniemi (1997) shown that apparent positive association found between stress and neck and shoulders symptoms. Stress among students can be attributed to assignments deadlines, exams, financial problem or personal problems. For students, their job strain is due to assignments to be accomplished and the amount it is usually beyond their control, especially post graduate students. The demand is tremendous in order to meet the requirements of the courses taken.

2.4.2.5 Gender

Numerous study have a rather consistent findings that women tend to be at a higher risk for developing MSDs than men (Andersen et al., 2008; Bernard et al., 1993; Blatter & Bongers, 2002; Jensen, Finsen, Sogaard & Christensen, 2002; Juul-Kristensen et al. 2004). Women also reported to be exposed more to harmful physical and psychosocial conditions than men. Karlqvist et al. 2002 found that 72% of female participants experience MSDs symptoms in all body regions compared to men 51% . Another explanations by Sommerich et al. 2006 mentioned that mismatches exist between female workers and their workstations (which may be built to suit males better), strength requirements to perform the tasks, women's higher tendency to report problems and additional responsibilities outside of work or biological differences.

2.4.2.6 Age

A recent study by Cagnie et al. (2007) and Hogg-Johnson et al. (2009), pointed out that the risk of neck pain increased with age until the age of 50. This is supported by findings from the Bone and Joint Task Force which reported that older workers were more likely to develop neck pain than their younger counterparts, with risk peaking in the fourth and fifth decades of life (Côté et al., 2009). In this study, this is not as the sample of the study is young student, less than 30 years old.

2.4.2.7 History of musculoskeletal symptoms

Reviews of the literature have demonstrated an increase in risk for development of neck pain associated with prior history of MSDs pain (Côté et al., 2009). It was found that experiencing neck pain in the past and a history of low back pain increased the risk of developing neck pain in an adult population (Croft et al., 2001; Hogg-Johnson et al., 2009). Smedley et al. (2003) also reported similar findings among population of nurses, where the risk of developing neck or shoulder pain was increased in those who had previous pain within the neck/shoulder or low back

2.4.8 Body region complaints

A study conducted by Hupert et al. (2004) found that more than half of their survey students reported upper extremity body pain or discomfort when using computer.

Similarly, Smith and Leggat (2004) found that 80 percent of Australia nursing students reported body region complaints related to computer use especially upper extremity. A research by Jenkins et al. (2007) reported that the regions with the highest prevalence pain or discomfort were the neck(72%), shoulder (56%) and wrist (51%). Schlossberg et al. (2004) study among engineering graduate students found that 62 percent of them reported persistent or recurrent upper extremity or neck pain related to computer use.

2.5 Summary

In summary, musculoskeletal disorders has become a global public health issues with high prevalence and tremendous economic burden to respective country. With technology advancement and service sector oriented work has increased, the use of computer indirectly on the rise as well. In order to prepare for future workers, some educational institutions have focused on daily use of technology and even implemented computer based education. Jacobs et al. (2009) mentioned that the rates of laptop computer use and ownership increased substantially from 2005 to 2009. In spite of this, little is known on the risks associated with computer use in terms of musculoskeletal problems.

After review of the literature, it was found that the following are risks factors related to computer use : body posture, duration of computer use, psychosocial factors i.e. Job demand and job control, workstation and work environment and history of musculoskeletal problems. In this study, the association of these independent variables to musculoskeletal disorders (dependent variable) among Megatech Institute students is investigated.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the research methodology of the study. It covers discussion on research design, definition of key terms, population and sampling design, instruments used, data collection procedures and statistical analysis performed in the research to ensure that the objectives of this study are met.

3.2 Research Framework and Hypotheses of the Study

Independent Variables **Dependent Variable**

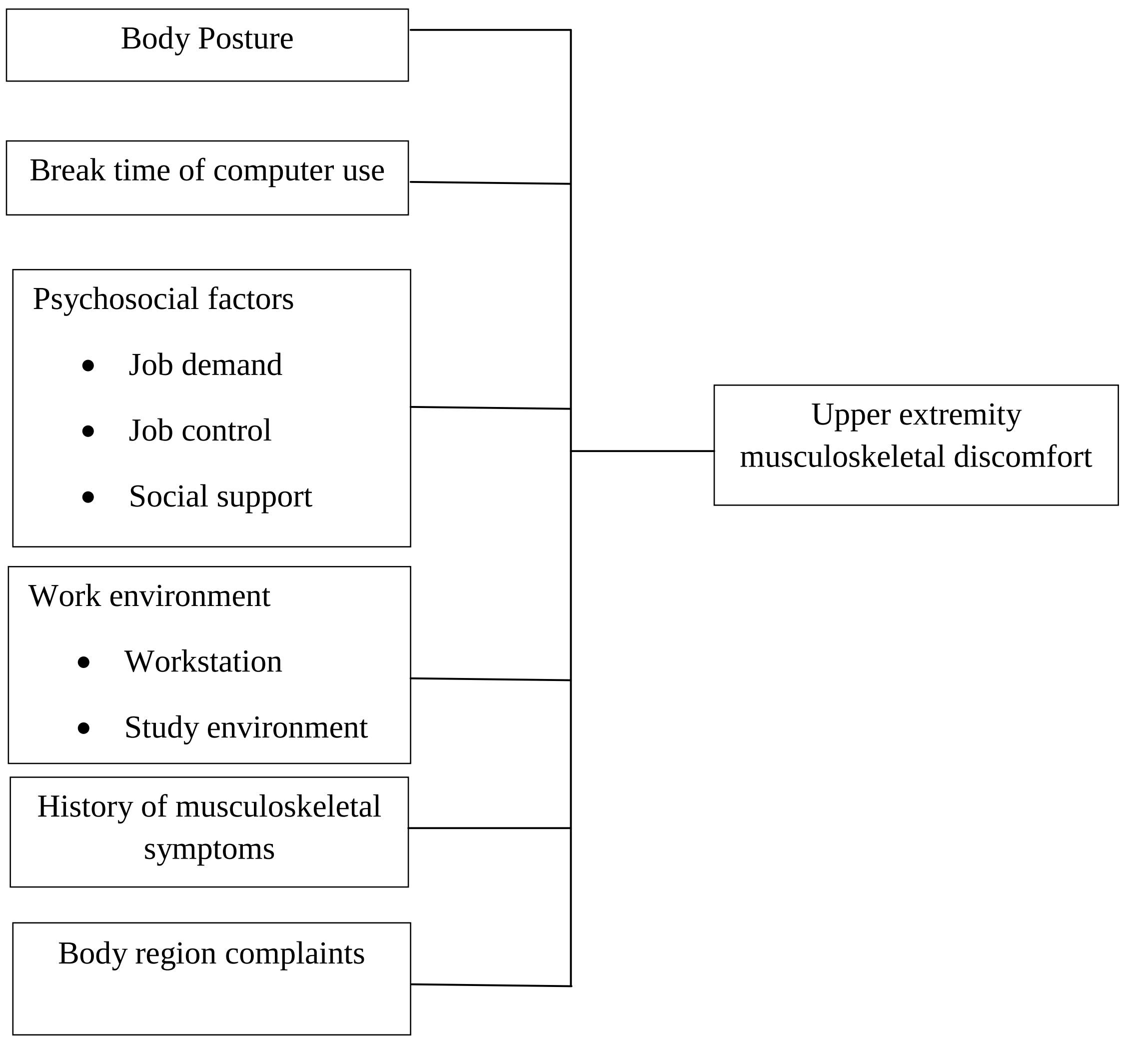

Figure 3-1
Research Framework

Figure 3-1 depicted the research framework for the study. The independent variables are body posture, break time, psychosocial factors, work environment, history of musculoskeletal symptoms and body region complaints. Upper extremity musculoskeletal discomfort is the dependent variable.

Hypotheses of the study

Based on the research questions and research objectives of this study, taking into considerations of the literature review done, the following hypotheses are postulated:

a) **Hypothesis 1**

H_0 : There is no positive relationship between body postures and upper extremity musculoskeletal discomfort among university students.

H_A : There is a positive relationship between body postures and upper extremity musculoskeletal discomfort among university students.

b) **Hypothesis 2**

H_0 : There is no positive relationship between break time of computer usage and upper extremity musculoskeletal discomfort among university students.

H_A : There is a positive relationship between break time of computer usage and upper extremity musculoskeletal discomfort among university students.

c) **Hypothesis 3**

H_0 : There is no positive relationship between psychosocial factors and upper extremity musculoskeletal discomfort among university students.

H_A : There is a positive relationship between psychosocial factors and upper extremity musculoskeletal discomfort among university students .

d) Hypothesis 4

H_0 : There is no positive relationship between work environment and upper extremity musculoskeletal discomfort among university students.

H_A : There is a positive relationship between work environment and upper extremity musculoskeletal discomfort among university students .

e) Hypothesis 5

H_0 : There is no positive relationship between history of musculoskeletal symptoms and upper extremity musculoskeletal discomfort among university students.

H_A : There is a positive relationship between history of musculoskeletal symptoms and upper extremity musculoskeletal discomfort among university students .

f) Hypothesis 6

H_0 : There is no positive relationship between body region complaints and upper extremity musculoskeletal discomfort among university students.

H_A : There is a positive relationship between body region complaints and upper extremity musculoskeletal discomfort among university students.

g) Hypothesis 7

H_0 : The factors (body posture, break time, psychosocial factors, work environment, history of musculoskeletal symptoms, body region complaints) do not influence upper extremity musculoskeletal discomfort among university students .

H_A : The factors (body posture, break time, psychosocial factors, work environment, history of musculoskeletal symptoms, body region complaints) influence upper extremity musculoskeletal discomfort among university students .

3.3 Research Design

This research involves the collection of primary and secondary data. In this study, secondary data gathered through literature reviews from journals, books and internets. Primary data is collected through the questionnaires distributed to related college students. The type of research is cross-sectional field study. It is carried out once and represents a snap shot of one point in time. Data were collected using respondent-complete questionnaires. It is design to determine the relationship between the independent variables i.e. risk factors associated with computer use and upper extremity discomfort among students as the dependent variables. In this research, the data is collected randomly and the respondents are given ample time i.e. two weeks to answer the questionnaires without any pressure exerted. Hopefully the answers given are the reflections of the real condition.

3.4 Definition of key terms

The key terms that are used in this study are upper extremities musculoskeletal discomfort, break time of computer use, psychosocial factors, body postures and work environment,

a) Upper extremities musculoskeletal discomfort

Upper extremity discomfort is the discomfort that affect the upper back, neck, shoulders, arms, wrists and fingers. The symptoms considered as discomfort, among others, are pain, aching, soreness, weakness tingling sensation and numbness during use of the extremities (Hamilton et al., 2005).

b) Break time of computer use

Break time of computer usage is in terms of when and how many hours ones uses computer in a day before a break. Increased in hours of computer work and reduced in break time are associated with increased musculoskeletal discomfort prevalence in all parts of the body (Gerr, Monteilh & Marcus, 2006)

c) Body postures

The orientation of the body in relation to workstation, sitting long hours, awkward postures, and repetitive movements (Limanowski, 2010)

d) Work environment

It is concerning the ergonomics aspect of computer workstations and the condition of the workstation for example lighting, temperature, noise, air and ventilation (Andersen et al., 2008).

e) History of musculoskeletal symptoms

Had previous pain or discomfort within the upper musculoskeletal extremity (neck, shoulder, arm, elbow, forearm, wrist and hand) (Côté et al., 2009).

f) Psychosocial factors (job demand, job control and social support).

In this study, job demand refers to the need and time taken to complete the task given by lecturers. Job control is one's ability to manage the task given and social support refers to colleagues and lecturers (Côté et al., 2009).

g) Body region complaints

Body region complaints in upper extremity MSDs are disorders that affect the neck, shoulders, arms, wrists, elbows and fingers. Their symptoms include soreness, pain, aching, weakness, tingling and numbness during use of the extremities (Hamilton et al., 2005).

3.5 Population and Sample

3.5.1 Population of the Study

This research is a quantitative analysis survey conducted at Megatech Institute. Participants are recruited from undergraduate students from all courses. All students are eligible. Personal identifying information that participants provided is not link with the survey. Letter of intention for the survey is submitted to the college student affairs department on the 4th May, 2012.

3.5.2 Sample of the study

After getting approval from the college committee, all 200 students are invited to participate in this study. A random sampling is done. The sample size is 132 respondents according to Krejcie & Morgan Table (1970). All questionnaires are circulated to this student via the Students Affair Units. A briefing on how to answer the survey is given to a person-in-charged in distributing the questionnaires. Prior to this, the questionnaires are pilot tested on 30 students for their comprehension and feasibility of administration. The survey is conducted from 11th June till 17th June 2012. The questionnaires are collected then.

3.6 The Survey Instrument

This is a questionnaire based study. Data that gathered by this questionnaire are demographic information and risk factors for upper extremity discomfort associated with computer use. Objective of the study explained clearly to the participants before questionnaires are distributed. Furthermore, all information provided in the questionnaires will be used for this study only, confidentiality highlighted.

Maastricht Upper Extremity Questionnaire (MUEQ) is used in this study. It is taken from BMC Musculoskeletal Disorders (2007). This questionnaire is used for study on Prevalence of complaints of arm, neck and shoulder among computer office workers and psychometric evaluation of a risk factor questionnaire by Eltayeb et al. 2007. The questionnaires comprises 3 sections.

Section 1 of the questionnaire is demographic information of the respective respondents. It includes gender, age, race, hours of computer use in a day, computer ownership, type of computer owned and type of program and year of study. There are altogether 7 questions to be answered by respondents in this first part.

Section 2 consists of seven parts related to risk factors for upper extremity discomfort associated with computer use. These questions are taken from Maastricht Upper Extremity Questionnaire (MUEQ). Modifications made for race of students to suit Malaysian students race i.e. Malay, Chinese, India and Others.

Part I is about workstation. It consists of 7 questions and the format is Likert-scale, 1 to 6 scales. 1-Strongly disagree 2-disagree 3-Slightly Disagree 4 – Slightly Agree 5-Agree 6-Strongly agree. The idea is to determine whether workstation arrangement influences the upper extremity discomfort or not. Total score for this part is calculated by adding the score for each question.

The next part of the questionnaire, Part II, on body posture. This part comprises 9 questions pertaining to body posture while using computer. The format is Likert-Scales 1 to 5. 1- Never 2- Seldom 3- Sometimes 4-Often 5- Always. Respondents need to tick the best answer represent their condition.

Part III and IV are about job control and job demand. These are Likert-scale based answer too, 1- Never 2- Seldom 3- Sometimes 4-Often 5- Always. Each has 5 questions respectively. They contribute to psychosocial factors that associated with upper extremity discomfort among computer users. Here, job means assignment, tasks related to study and research to collect information pertaining to study.

Part V is asking the respondent questions on break time when using the computer. There are 8 questions asked to determine whether break time related to upper extremity discomfort. These are Likert-scale based answer too, 1- Never 2- Seldom 3- Sometimes 4-Often 5- Always. Each has 5 questions respectively.

Part VI is work environment. There are 5 questions concerning work environment. These are Likert-scale 1 to 5 based answer too. 1- Never 2- Seldom 3- Sometimes 4-Often 5- Always. Study environment and workstation are considered as one risk factor that contributes to upper extremity discomfort.

Part VII is on social support for the students. These are Likert-scale 1 to 5. 1- Never 2- Seldom 3- Sometimes 4-Often 5- Always. The supports are from lecturers and peer group. This factor is assessed under psychosocial factor.

Section 3 is related to complaints and history of upper extremity musculoskeletal discomfort. Questions asked are about body regions in upper extremity that experience pain. The scale used are Likert-scale 1 to 5 (1- Never 2- Seldom 3- Sometimes 4-Often 5- Always) .

The subsequent questions are on the effect of the problem, what has been done and the nature of the discomfort. Likert-scale 1 to 6 (1-Strongly disagree 2-disagree 3-Slightly Disagree 4 – Slightly Agree 5-Agree 6-Strongly agree) are used.

In summary, this study identifies risk factors associated with computer use that could influence the prevalence of upper extremity musculoskeletal discomfort among college students.

3.7 Reversed-Scored Items and Back Translation

If a questionnaire includes positively-keyed and negatively-keyed items, then the negatively-keyed items must be “reverse-scored” before computing individuals’ total scores. Positively-keyed items are items that are phrased so that an agreement with the item represents a relatively high level of the attribute being measured. Negatively-keyed items are items that are phrased so that an agreement with the item represents a relatively low level of the attribute being measured. Items that are reversed in meaning from the overall direction of the scale are called reversal items. There is a need to reverse the response value for each of these items before summing for the total. That is, if the respondent gave a 1, make it a 5; if they gave a 2, make it a 4; 3 = 3; 4 = 2; and, 5 = 1. Social support question number 2 has been reversed-scored. After reverse coding SS2 become SS2R and this is used for analysis.

Back-Translation is the practice of taking a translated document and translating it back into the original language as a means of checking the accuracy of the translation. The most frequently employed translation technique is back-translation (Brislin, 1970). In this procedure, the original version of the questionnaire is translated into the target language and subsequently translated back into the source language by a second bilingual person. The use of two independent translators increases the chances that the original meaning has been retained, ensures literal accuracy and helps to detect mistakes. Harpaz (2003) identifies two additional translation techniques: bilingual method and committee procedure. The former approach involves sending the original and the translated questionnaire to bilingual individuals and subsequently correcting items based on inconsistencies in their responses. In contrast, in the latter approach a committee consisting of bilingual individuals translates the questionnaire jointly and discusses possible mistakes or difficulties. Finally, to cross-check for possible translation mistakes and to ensure comprehension of the translated questionnaire among respondents, pilot testing is particularly important in international research.

3.8 The Pilot Study

The pilot study is carried out to test the reliability for the statement in the questionnaires . 30 questionnaires are distributed among the students in Megatech Institute to ensure that the questionnaires are clear and easily understood by respondents. The reliability is conducted on Likert-scale type of questions to ensure that the respondents are able to answer without misunderstanding on each question. Reliability addresses the consistency of the results. It is mostly measured by Cronbach's alpha, which is an indication of internal consistency and the degree to which the items are homogenous (Cooper &Emory, 1995; Saraph et al., 1989). The reliability analysis testing is done using SPSS software. The measurement of the internal consistency of the variables varies from 0 to 1. The acceptable value of Cronbach's alpha is recommended to be 0.6 (Flynn et al., 1994; Hair et al., 2006). A low value could be due to low number of questions, poor inter-related between items or heterogeneous constructs. If a low alpha value due to poor correlation between items, then some should be revised or discard. If the value is too high, it may suggest that some items are redundant as they are testing the same questions but in different guise.

3.9 Data Collection Procedure

This is questionnaire based survey. Data is collected by questionnaire designed to gather demographic information and risk factors related to upper extremity discomfort among computer users after the approval from the college.

Objectives of this study are written clearly in the questionnaires and whenever required the researcher shall explain again the objectives of the study to the participants before questionnaire is distributed. It is important to emphasize to the respondents that all information gathered is strictly confidential and will be used for the purpose of the study only.

The questionnaire both in Bahasa Malaysia and English are distributed to respondent by the Students Affairs Unit executive who has been briefed earlier. The respondents are asked to tick (/) the box provided in the rating scale that best represent their answers. There are three sections: general information, risk factors associated with computer use and history of musculoskeletal discomfort. Section 2 has seven parts related to risk factors for upper extremity musculoskeletal discomfort. The survey is conducted from 11th June till 17th June 2012. The respondents are from all courses that have been selected randomly. To ensure good participation and response, they are given 20 minutes to answer the questionnaire during their class and the questionnaires are collected then by the person-in-charged. Prior to this, pilot test was done .

3.10 Analysis of Data

3.10.1 Data Screening and Normality Distribution

Missing data is information from participants that is not available for one or more variables of interest. It could be due to participants accidentally skip, refuse to answer, do not know the answer, participants dropping out of the study, or being absent for one or more data collection periods, researcher error, corrupted data files or changes in research or instrument design after data were collected. Select appropriate missing data techniques and it can avoid bias in subsequent analysis. There are 3 types of missing data (Howell, 2007).

1. **Data missing completely at random (MCAR)**

The probability that a particular variable is not dependent on the variable itself and is not dependent on another variable in the data set.

2. **Data missing at random (MAR)**

The probability that a particular variable is missing is not dependent on the variable itself but dependent on another variable in the data set. Example: the answer to the first question of a branched-question set might cause missing data to the second question within the branched-question set.

3. **Data missing but not missing at random (NMAR)**

Missing data are not predictable from other variables in the data set.

3 methods can be used for data sets with missing data :

a. **Listwise deletion**

Cases with missing data on one variable are deleted from the sample for all analyses of that variable.

b. **Pairwise deletion**

Missing data are estimated using all cases that have data for each variable or pair of variables : the estimation replaces the missing data.

c. **Predictive replacement**

Missing data are predicted from observed values on another variable; the observed values are used to replace the missing data.

Parametric analysis requires the sample to have normal distribution. If the distribution is not normal, transform the variable to make it normal. The assumption of normality is a prerequisite for many inferential statistical techniques. 2 methods of determining normality of distribution graphical methods (such as histograms, stem-and-leaf plots and boxplots) or using statistical procedures (such as the Kolmogorov-Smirnov statistic and the Shapiro-Wilks statistics). Shapiro-Wilk Test is more appropriate for small sample sizes (< 50 samples) but can also handle sample sizes as large as 2000. For this reason, the Shapiro-Wilk test as our numerical means of assessing normality is used. If the Sig. value of the Shapiro-Wilk Test is greater the 0.05 then the data is normal. If it is below 0.05 then the data significantly deviate from a normal distribution (Laerd Statistic, 2012).

3.10.2 Reliability of Instrument

The reliability analysis testing is done using SPSS software. To measure the internal consistency of variable construct, use Cronbach's Alpha which varies from 0 to1. The Cronbach's Alpha of less 0.6 normally indicates unsatisfactory internal consistency reliability. If Cronbach's Alpha of 0.6 or more (Flynn et al., 1994; Hair et al., 2006), it normally indicates satisfactory internal consistency reliability.

3.10.3 Descriptive Statistic

Descriptive Statistic involves the transformation of raw data into a form that would provide information to describe a set of factors in a situation. Descriptive Statistic is about frequencies, measures of central tendency i.e. mean, median, mode and dispersion (range, standard deviation and variance).

3.10.4 Hypotheses Testing

The data collected is analysed using the Statistical Package for Social Sciences (SPSS) version 19.0. The variable for each item in the questionnaires are defined and assigned according to the respective parts in the questionnaires and their number. The reliability test is conducted to ensure the reliability of the instruments used in the study. The collected data is analysed using descriptive statistic techniques such as frequency, central tendency and dispersion and correlation. Pearson's correlation test is used to measure the strength of the relationship between the research variables. Multiple regression analysis is also applied. The general purpose of multiple regression is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable. Customarily, the degree to which two or more predictors (independent or X variables) are related to the dependent (Y) variable is expressed in the correlation coefficient R, which is the square root of R-square. In multiple regression, R can assume values between 0 and 1. To interpret the direction of the relationship between variables, look at the signs (plus or minus) of the regression or B coefficients. If a B coefficient is positive, then the relationship of this variable with the dependent variable is positive (e.g., the greater the IQ the better the grade point average); if the B coefficient is negative then the relationship is negative (e.g., the lower the class size the better the average test scores). Of course, if the B coefficient is equal to 0 then there is no relationship between the variables (StatSoft, Inc., 2012)

3.11 Approval from Megatech Institute .

Letter to Megatech Institute is sent to inform about the intention to conduct the study here and also asking for permission.

Approval letter was received on 6 June 2012 as in Appendix 2.

3.12 Summary

In conclusion, chapter 3 discussed the broad research framework, the data collection and data analysis method used in the study. In general, the risk factors associated with computer use have been identified such as duration of use, body posture, psychological factors, history of musculoskeletal discomfort, workstation and work environment (ergonomics). In this study, the relationship between these factors and prevalence of upper extremity discomfort are determined.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter describes the detail result generated from the questionnaires given to the respondents who are Megatech Institute students. The data generated from the questionnaire was analysed using descriptive statistics and inferential statistics from SPSS 19 software.

4.2 Distribution of questionnaire

The population size is 200 students in this institute and the sample is selected based on Krejcie and Morgan sampling technique. The sample size is 132 students, therefore 132 questionnaires were randomly distributed among the students. At the end of the data collection process, 2 questionnaires were not returned and 130 were accepted by the researcher. The distribution of the total questionnaires received and returned are described in table 4.

Table 4.1
Number of Questionnaire

Respondents	**Frequency**	**Percentage**
Total population	200	-
Distributed	132	-
Not return	2	1.5%
Accepted	130	98.5%

4.3 Reliability

The internal consistency of a set of measurements items refers to the degree to which items in the set are homogenous. Internal consistency can be estimated using reliability coefficient such as Cronbach's Alpha. The pilot study of 30 respondents was carried out to test the reliability of the instruments in this study. The Cronbach's Alpha of more than 0.6 indicated that the instrument in this study was reliable. Table 4.2 shows Cronbach's Alpha for all the tested items in the pilot study. There was no single missing value in the questionnaire given by the respondents. Typo errors were corrected prior to this.

Table 4.2
Reliability for Pilot Questionnaires

No	Variable	Items	Cronbach's Alpha
1.	Workstation	7	0.821
2.	Body posture	9	0.705
3.	Job control	5	0.811
4.	Job demand	5	0.776
5.	Break time	8	0.733
6.	Study environment	3	0.614
7.	Social support	6	0.719
8.	Complaints	7	0.924
9.	History	3	0.824
10.	Upper extremity discomfort	6	0.857
11.	Work environment (WS&SE)	12	0.709
12.	Psychosocial (JC,JD& SS)	16	0.736

The reliability of the instrument was conducted again for all 130 respondents at the end of this study. Table 4.3 shows the reliability analysis for all the variables. The Cronbach's Alpha of more than 0.6 indicates that the instrument used in this study is reliable and good (Flynn et al., 1994; Hair et al., 2006)

Table 4.3
Reliability for Final Questionnaires

No	Variable	Items	Cronbach's Alpha
1.	Workstation	7	0.842
2.	Body posture	9	0.785
3.	Job control	5	0.846
4.	Job demand	5	0.789
5.	Break time	8	0.793
6.	Study environment	3	0.604
7.	Social support	6	0.716
8.	Complaints	7	0.934
9.	History	3	0.868
10.	Upper extremity discomfort	6	0.834
11.	Work environment (WS&SE)	12	0.787
12.	Psychosocial (JC,JD& SS)	16	0.777

4.4 Demographic analysis

Part one of the questionnaire was intended to gain the information on the background of the respondents such as gender, race, age, duration of computer usage, ownership of computer and type of computer. The sample is an engineering student in private college.

4.4.1 Analysis of respondents based on gender

Table 4.4 shows the analysis of the respondents based on gender. Results showed that majority of the respondents in this study were male 81 (62.3%) compared to female 49 (37.7%). Population in this college majority are male students.

Table 4.4
Analysis of Respondents Based on Gender

Gender	Frequency (%)
male	81 (62.3)
female	49 (37.7)
Total	130 (100)

4.4.2 Analysis of respondents based on age

Table 4.5 shows the analysis of the respondents based on age. Results showed that majority of the respondents age ranging from 21 – 30 years. This is expected as they are college students and just embarked on their tertiary education.

Table 4.5
Analysis of the Respondents Based on Age

Age	Frequency (%)
< 20	50 (38.5)
21-30	80 (61.5)
Total	130 (100)

4.4.3 Analysis of respondents based on race

Table 4.6 & Table 4.7 show the analysis of the respondents based on race. Results showed that majority of the respondents were Malay (45.4%) followed by Indian (38.5%), Chinese (12.3%) and others (3.8%). The other races were Dusun, Kadazan, Melanau and Siamese.

Table 4.6
Analysis of Respondents Based on Race

Race	Frequency (%)
Malay	59 (45.4%)
Chinese	16 (12.3)
Indian	50 (38.5)
Others	5 (3.8)
Total	130 (100)

Table 4.7
Analysis of Respondents Based on Other Races

Other races	Frequency (%)
Dusun	1 (0.8)
Kadazan	1 (0.8)
Melanau	1 (0.8)
Siam	2 (1.4)
Total	5 (3.8)

4.4.4 Analysis of respondents based on duration of computer use daily

Table 4.8 is analysis of respondents based on duration of computer usage daily. The results demonstrated that majority of the respondents use the computer less than 4 hours per day (53.1%) followed by 4 – 6 hours per day (29.2%) and the usage of more than 6 hours constituted only 17.7 %. Therefore it can be concluded that all the respondents use computer daily, only the duration differs. Among female students, majority 49% used computer < 4 hours similar to male students 55%. Comparing both gender, majority were using computer < 4 hours daily.

Table 4.8
Analysis of Respondent Based on Duration of Computer Usage Daily

		Gender		
		male	female	Total
Time	< 4hrs	45 (55.6%)	24 (49.0%)	69 (53.1%)
	4-6hrs	18 (22.2%)	20 (40.8%)	38 (29.2%)
	> 6hrs	18 (22.2%)	5 (10.2%)	23 (17.7%)
	Total	81 (100.0%)	49 (100.0%)	130 (100.0%)

4.4.5 Analysis of respondents based on computer ownership

Table 4.9 is analysis of respondents based on computer ownership among the respondents. Majority of male and female respondents own a computer 92.6% and 95.9% respectively. Only 6.2 % do not have a computer. It can be concluded that students use computer widely in college.

Table 4.9
Analysis of Computer Ownership.

		Gender		
		male	female	Total
Ownership	yes	75 (92.6%)	47 (95.9%)	122 (93.8%)
	No	6 (7.4%)	2 (4.1%)	8 (6.2%)
Total		81 (100.0%)	49 (100.0%)	130 (100.0%)

4.4.6 Analysis of respondents based on type of computer

Table 4.10 is analysis of respondents based on type of computer owned by them. The results revealed that majority of them owned either a laptop or notebook only (66.4%) followed by desktop only (22.9%) and 10.7 percent of respondents have both type of computer. The results implied to us that the usage of computer is very rampant in today's world.

Table 4.10
Analysis of Respondents Based on Type of Computer

Type of computer	Frequency (%)
desktop	28 (22.9)
laptop/notebook	81 (66.4)
both	13 (10.7)
Total	122 (100)

4.4.7 Analysis of respondents based on the course taken

Table 4.11 is analysis of respondents based on the course taken. As shown in the table below, electrical and electronic engineering students constitute the majority of respondents (67.7%) as compared to mechatronics engineering respondents (32.3%)

Table 4.11

Analysis of Respondents Based on the Course Taken

Course	Frequency (%)
Electrical & Electronic Engineering	88 (67.7)
Mechatronic Engineering	42 (32.2)
Total	130 (100)

4.5 Descriptive statistic

4.5.1 Analysis of Gender and Break Time

Table 4.12

Analysis of Gender and Break Time

		Break time			
		Never	Seldom & Sometimes	Often & Always	Total
Gender	male	2 (40.0%)	63 (63.0%)	16 (64.0%)	81 (62.3%)
	female	3 (60.0%)	37 (37.0%)	9 (36.0%)	49 (37.7%)
Total		5 (100.0%)	100 (100.0%)	25 (100.0%)	130 (100.0%)

The results in table 4.12 revealed that 63 male students and 37 female students were seldom or sometimes only had a break time when working on computer. Only 2 male and 3 female never had any break when they use computer

4.5.2 Analysis of Gender and Complaints

Table 4.13

Analysis of Gender and Complaints

		complaint			
		Never	Seldom & Sometimes	Often & Always	Total
Gender	male	39 (70.9%)	33 (50.8%)	9 (90.0%)	81 (62.3%)
	female	16 (29.1%)	32 (49.2%)	1 (10.0%)	49 (37.7%)
Total		55 (100.0%)	65 (100.0%)	10 (100.0%)	130 (100.0%)

The findings in table 4.13 have shown that 39 male students and 16 female students never had complaints of musculoskeletal discomfort. Majority of female students 49.2% seldom and sometimes have complained of musculoskeletal discomfort.

4.5.3 Analysis of Gender and History of symptoms

Table 4.14

Analysis of Gender and History of Musculoskeletal Symptoms

		History		
		Disagree	Agree	Total
Gender	male	73	8	81
		(62.9%)	(57.1%)	(62.3%)
	female	43	6	49
		(37.1%)	(42.9%)	(37.7%)
Total		116	14	130
		(100.0%)	(100.0%)	(100.0%)

The result as depicted in table 4.14 revealed that 57.1% (8) of male students and 42.9% (6) of female agreed that they have history of musculoskeletal symptoms. Overall, 116 students did not agree with history of musculoskeletal symptoms.

4.5.4 Analysis of Gender and Posture

Table 4.15

Analysis of Gender and Posture

		posture			
		Never	Seldom & Sometimes	Often & Always	Total
Gender	male	2	70	9	81
		(100.0%)	(61.9%)	(60.0%)	(62.3%)
	female	0	43	6	49
		(0%)	(38.1%)	(40.0%)	(37.7%)
	Total	2	113	15	130
		(100.0%)	(100.0%)	(100.0%)	(100.0%)

Table 4.15 revealed that both gender are generally either seldom or sometimes having awkward posture. Similar findings noted among gender.

4.5.5 Analysis of Gender and Psychosocial

Table 4.16
Analysis of Gender and Psychosocial

		psychosocial			
		Never	Seldom & Sometimes	Often & Always	Total
Gender	male	0 (0%)	68 (62.4%)	13 (65.0%)	81 (62.3%)
	female	1 (100.0%)	41 (37.6%)	7 (35.0%)	49 (37.7%)
Total		1 (100.0%)	109 (100.0%)	20 (100.0%)	130 (100.0%)

The findings in table 4.16 shown that 109 of the students seldom or sometimes had psychosocial factors in both gender. Only 1 student never had any psychosocial factors.

4.5.6 Analysis Part of Upper Extremity Discomfort

Based on the analysis done on Complaints Specify, majority of the discomfort were on the right side for all parts i.e. shoulder, arm, elbow, forearm, wrist and hand. This could be due to the respondents were right-handed. However, this information was not gathered during the study. The results for complaints specify are on Appendix 5.

4.5.7 Analysis Upper Extremity Discomfort Symptoms

Analysis Upper Extremity Discomfort Symptoms revealed that students commonly experience fatigue and exhaustion 63%, stiffness in the fingers 58% and numbness 46%. Whereas tingling 20%, weakness 17% and swelling 6.2% were experienced by minority of students. The results for Analysis Upper Extremity Discomfort Symptoms are in appendix 6.

4.5.8 Priority of variables

Table 4.17
Descriptive Statistics

	N	Mean	Std. Deviation
Work station	130	4.0582	.94203
Body posture	130	3.0889	.62340
Job control	130	3.7077	.76276
Job demand	130	3.1477	.75310
Break time	130	3.2769	.67575
Environment	130	3.4256	.77094
Social support	130	3.6487	.66804
Complaints	130	2.2670	1.02760
History	130	1.9231	1.15137
UED	130	2.7051	1.06598

From table 4.17 it is seen that the mean on history were rather low (1.92 on six-point scale), as also are mean on the upper extremity discomfort (2.70 on a six-point scale) and mean for complaints (2.26 on five-point scale). Mean for job demand (3.1), body posture (3.0), workstation (4.0) and break time (3.2) are about average. Meanwhile, for job control (3.70), social support (3.6) and study environment (3.4) are perceived as somewhat enriched. All variables are tapped on a five-point scale except for workstation and history of musculoskeletal discomfort that was tapped on a six-point scale.

4.6 Hypotheses analysis

4.6.1 Correlation

The research hypotheses were tested for the relationship between independent and dependent variable. In this study, Pearson correlation analysis was applied to see the correlation between two variables. A bivariate Pearson's product-moment correlation coefficient was computed to assess the relationship between the independent variables (body posture, break time, work environment, psychological factors, complaints and history of musculoskeletal discomfort) and dependent variable (upper extremity musculoskeletal discomfort).

i. Hypothesis 1

H_0 : There is no positive relationship between body postures and upper extremity musculoskeletal discomfort among university students.

H_A : There is a positive relationship between body postures and upper extremity musculoskeletal discomfort among university students .

From Table 4.20, it showed that there was a positive correlation between upper extremity musculoskeletal discomfort and body posture, where $r = 0.243$, $n = 130$, $p < 0.05$. Thus, alternate hypothesis was accepted. Overall, there was a low positive relationship between upper extremity musculoskeletal discomfort and body posture (24.3%). It means that increases in upper extremity musculoskeletal discomfort were correlated with increases in poor body posture.

Table 4.18
Correlations Between Body Posture and UED

		Body posture	UED
Body posture	Pearson Correlation	1	.243**
	Sig. (2-tailed)		.005
	N	130	130

**. Correlation is significant at the 0.01 level (2-tailed).

ii. Hypothesis 2

H_0 : There is no positive relationship between break time of computer usage and upper extremity musculoskeletal discomfort among university students.

H_A : There is a positive relationship between break time of computer usage and upper extremity musculoskeletal discomfort among university students .

Table 4.19
Correlations Break Time and UED

		UED	Break time
UED	Pearson Correlation	1	.071
	Sig. (2-tailed)		.419
	N	130	130

As for break time, it was seen that there was no correlation between upper extremity musculoskeletal discomfort and break time, where $r = 0.071$, $n = 130$, $p > 0.05$. Thus, null hypothesis has to be accepted. Overall, there was no relationship between upper extremity musculoskeletal discomfort and break time.

iii. Hypothesis 3

H_0 : There is no positive relationship between psychosocial factors (job demand, job control and social support) and upper extremity musculoskeletal discomfort among university students .

H_A : There is a positive relationship between psychosocial factors (job demand, job control and social support) and upper extremity musculoskeletal discomfort among university students .

Table 4.20
Correlations Psychosocial Factors and UED

		UED	Psychosocial
UED	Pearson Correlation	1	.187*
	Sig. (2-tailed)		.033
	N	130	130

*. Correlation is significant at the 0.05 level (2-tailed).

The result presented in table 4.22 showed that there was a positive correlation between upper extremity musculoskeletal discomfort and psychosocial factors, where r = 0.187, n = 130, $p < 0.05$. Thus, alternate hypothesis was accepted. Overall, there was a low positive relationship between upper extremity musculoskeletal discomfort and body posture (18.7%). It means that increases in upper extremity musculoskeletal discomfort were correlated with increases in psychosocial factors.

iv. Hypothesis 4

H_0 : There is no positive relationship between work environment (workstation and study environment) and upper extremity musculoskeletal discomfort among university students .

H_A : There is a positive relationship between work environment (workstation and study environment) and upper extremity musculoskeletal discomfort among university students .

Table 4.21

Correlations Work Environment and UED

		Work environment	UED
Work environment	Pearson Correlation	1	.056
	Sig. (2-tailed)		.523
	N	130	130

As depicted in table 4.23, it was seen that there was no correlation between upper extremity musculoskeletal discomfort and work environment, where r = 0.05, n = 130, $p > 0.05$. Thus, null hypothesis has to be accepted. Overall, there was no relationship between upper extremity musculoskeletal discomfort and work environment.

v. Hypothesis 5

H_0 : There is no positive relationship between history of musculoskeletal symptoms and upper extremity musculoskeletal discomfort among university students .

H_A : There is a positive relationship between history of musculoskeletal symptoms and upper extremity musculoskeletal discomfort among university students.

Table 4.22

Correlations History and UED

		History	UED
History	Pearson Correlation	1	.337**
	Sig. (2-tailed)		.000
	N	130	130

**. Correlation is significant at the 0.01 level (2-tailed).

The result revealed that there was a positive correlation between upper extremity musculoskeletal discomfort and history of musculoskeletal symptoms, where $r = 0.337$, $n = 130$, $p < 0.05$. Thus, alternate hypothesis was accepted. Overall, there was a marginal positive relationship between upper extremity musculoskeletal discomfort and body posture (33.7%). It means that increases in upper extremity musculoskeletal discomfort were correlated with history of musculoskeletal symptoms.

vi. Hypothesis 6

H_0 : There is no positive relationship between body regions complaints and upper extremity musculoskeletal discomfort among university students .

H_A : There is a positive relationship between body regions complaints and upper extremity musculoskeletal discomfort among university students.

Table 4.23
Correlations Complaints and UED

		COMPLAINTS 2	UED
Complaints	Pearson Correlation	1	.546**
	Sig. (2-tailed)		.000
	N	130	130

**. Correlation is significant at the 0.01 level (2-tailed).

The result revealed that there was a positive correlation between upper extremity musculoskeletal discomfort and complaints of musculoskeletal symptoms, where $r = 0.546$, $n = 130$, $p < 0.05$. Thus, alternate hypothesis was accepted. Overall, there was a moderate positive relationship between upper extremity musculoskeletal discomfort and complaints (54.6%). It means that increases in upper extremity musculoskeletal discomfort were correlated with complaints of musculoskeletal symptoms.

4.6.2 Multiple regression

vii. Hypothesis 7

H_0 : The factors (body posture, work environment, psychosocial, break time, body region complaints and history of musculoskeletal symptoms) do not influence upper extremity musculoskeletal discomfort among university students.

H_A : The factors (body posture, work environment, psychosocial, break time, body region complaints and history of musculoskeletal symptoms) influence upper extremity musculoskeletal discomfort among university students .

Table 4.24

Multiple Regression

R	R Square	Adjusted R Square	Std. Error of the Estimate
.598[a]	0.358	0.327	0.87462

a. Predictors: (Constant), Psychosocial, body region complaints, Body posture, History of musculoskeletal symptoms, Work Environment, Break time

b. Dependent Variable: Upper extremity discomfort

ANOVA[b]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	52.496	6	8.749	11.438	.000[a]
Residual	94.089	123	0.765		
Total	146.585	129			

Coefficients[a]

	Unstandardized Coefficients	Standardized Coefficients	t	Sig
	B	Beta		
(Constant)	-0.238		-.375	.709
Body posture	0.079	0.046	.567	.572
Break time	-0.152	-0.096	-1.051	.295
Complaints	0.492	0.475	5.794	.000
History	0.14	0.151	1.878	.063
Work environment	0.019	0.012	0.137	.892
Psychosocial	0.502	0.229	2.426	.017

The six IVs (body posture, work environment, psychosocial, break time, body region complaints and history of musculoskeletal symptoms) significantly explain the variance in DV (upper extremity musculoskeletal discomfort). Multiple regression analysis was used to evaluate the effects of IVs on dependent variable DV (upper extremity musculoskeletal discomfort). As depicted in Table 4.26, the regression results revealed the R square value of 0.358. This indicates that 32.7 percent of variance that explained the upper extremity musculoskeletal discomfort was accounted for by the IVs where the F value = 11.438 at $p < 0.000$. Further, of the six dimensions IVs, only body regions complaints ($\beta = 0.475$, $p < 0.000$), and psychosocial factors ($\beta = 0.229$, $p < 0.001$) were significant predictors of upper extremity musculoskeletal discomfort.

Table 4.25
Summary of Findings

Hypotheses	Result
1. H_A : There is a positive relationship between body postures and upper extremity musculoskeletal discomfort among university students.	Supported
2. H_A : There is a positive relationship between break time of computer usage and upper extremity musculoskeletal discomfort among university students .	Rejected
3. H_A : There is a positive relationship between psychosocial factors and upper extremity musculoskeletal discomfort among university students.	Supported
4. H_A : There is a positive relationship between work environment and upper extremity musculoskeletal discomfort among university students.	Rejected
5. H_A : There is a positive relationship between history of musculoskeletal symptoms and upper extremity musculoskeletal discomfort among university students.	Supported
6. H_A : There is a positive relationship between body region complaints and upper extremity musculoskeletal discomfort among university students.	Supported
7. H_A : The factors (body posture, work environment, psychosocial, break time, body region complaints and history of musculoskeletal symptoms) influence upper extremity musculoskeletal discomfort among university students.	Supported *Body region complaints *Psychosocial Rejected *Body posture *work environment *break time *history of musculoskeletal symptoms

Table 4.27 summarizes the results of the analysis. The results of this study pointed out that body posture, psychosocial factors, history of musculoskeletal discomfort, body regions complaints were found to have significant positive relationship with upper extremity musculoskeletal discomfort. However, break time and work environment were not found to have significant positive relationship with upper extremity musculoskeletal discomfort.

4.7 Discussion

4.7.1 Demography of the respondents

Majority of the respondents in this study were male (62.3%) compared to female (37.7%). The population of students in this college majority is male therefore most of the respondents in this study are male. The respondents age majority range from 21 to 30 years old (61.5%) and 38.5% were younger than 21 years old. As for the race, 45.4% of the respondents were Malay and the rest were Indian (38.5%), Chinese (12.3%) and others (3.8%). Majority i.e. 122 (93.8%) respondents owned a computer compared to 8 (6.2%) who did not have a computer. As for computer type, 62.2% had laptop, 21.5% had desktop and 16.2% had both laptop and desktop. The respondents were from Electrical and Electronic Engineering Course (67.7%) and Mechatronic Engineering Course (32.3%). From the study, 53.1% of the respondents used computer less than 4 hours a day, 29.2% used computer between 4 to 6 hours a day and 17.7% spent more than 6 hours on computer.

4.7.2 Relationship between body postures and upper extremity musculoskeletal discomfort.

In this study, there was positive relationship between body posture and upper extremity discomfort. The respondents generally sometimes did not maintaining right body posture while using computer. This is consistent with study by Cooper, Sommerich and Mirka (2004) that shown students report statistically more frequent musculoskeletal discomfort compared to professionals in the region of upper extremity and back. According to Katz et al. (2000), 41% of university students reported experiencing musculoskeletal pain while using computer in upper extremity region due to body postures. Awkward body posture has also been associated with increased reporting of MSDs symptoms among computer users (Cook et al., 2000; Fagarasanu & Kumar, 2003). Additionally, Blatter and Bongers (2002) found that prolonged static posture has the strongest influence on MSDs incidence.

4.7.3 Relationship between break time and upper extremity musculoskeletal discomfort

Majority respondents have break time while using the computer. The findings found that 5 students never had a break time when working on computer. In this study, no significant association was found between break time and upper extremity discomforts. It was seen that there was no correlation between upper extremity musculoskeletal discomfort and break time. This is contrary to several studies which found positive relationship between duration of computer work and MSDs: increase hours of computer work and no break time are associated with increased MSDs prevalence in all parts of the body (Gerr, Marcus & Monteilh, 2004; Gerr, Monteilh & Marcus, 2006; Village, Rempel & Teschke, 2005). It is very clear why it is so often found in the research – the longer a person spends time working in computer, the longer he/she is maintaining awkward postures and performing repetitive motions, which eventually lead to pain and discomfort in upper extremities. A cross-sectional questionnaire study by Blatter and Bongers (2002) found that those who work with computer more than 6 hours per day were associated with upper extremities. In this study, no significant relationship found probably due to majority 82.3% of the respondents spent less than 6 hours daily on computer and they have break when using the computer. Study by Rossignol et al. (1987) reported an increase in prevalence ratio musculoskeletal symptoms of workers who worked 4-6 hours per day and over 7 hours. However study by Cook et al. (2000) found no association between total hours of computer use and musculoskeletal symptoms. Caution needs to be taken when considering the accuracy of reported work hours, as self-reports of computer work hours have been found to be overestimated (Faucett and Rempel, 1996) or unreliable (Marcus and Gerr, 1996). Bhanderi et al. (2008) study showed highly significant association between MSD and duration of computer use. Similarly, Karlqvist et al. (1996) found that more than 5.6 hours of mouse time per week increase risk of shoulder symptoms.

Certain degree of variability was observed among studies examining associations between computer use and musculoskeletal outcomes. Nevertheless, some consistent findings do emerge. Significant associations between daily or weekly hours of keyboard use and hand and arm MSD outcomes were observed in five cross-sectional studies. Three studies with positive associations between computer use and hand and arm MSD outcomes failed to observe such associations with neck and shoulder MSD outcomes (Marcus et al., 2002). These differences may indicate true biological differences in the effect of computer use on hand/arm and neck/shoulder MSD outcomes (Gerr et al, 2004).

4.7.4 Relationship between psychosocial and upper extremity musculoskeletal discomfort

Generally the respondents did experience to a certain degree lack of job control, high job demand and lack of social support. The mean for each item in this variable was between 3.0 to 3.7. There was positive relationship between psychosocial factors and upper extremity discomfort observed in this study. This is consistent with findings of other studies, there has been substantial evidence surrounding the effects of job strain (job demand, job control and social support) on health. Côté et al. (2009) found evidence suggested that high amounts of job strain can increase the risk and incidence of neck pain. Although job strain may not be an issue for student's population, there has been evidence that psychosocial factors such as stress do have an impact among students. Findings by Niemi, Levoska. Rekola and Keinanen-Kiukaanniemi (1997) shown that apparent positive association found between stress and neck and shoulders symptoms. Stress among students can be attributed to assignments deadlines, exams, financial problem or personal problems. For students, their job strain is due to assignments to be accomplished and the amount it is usually beyond their control, especially post graduate students. The demand is tremendous in order to meet the requirements of the courses taken. NIOSH in 1977 has out lined that five psychosocial factors that are related to the back and upper extremity disorders, i.e. job satisfaction, job demand, monotonous work, job control and social support. Bhanderi and co-workers (2008) in their study found association between upper extremity musculoskeletal disorders and support from peers as well as from seniors at workplace. Karlqvist et al. 2002 found that job demand was associated with high prevalence of musculoskeletal symptoms among female participants. Low job satisfaction predicted neck/shoulder pain and lower limb pain by participants in the study done by Andersen et al. 2007. The addition of mental demands during computer work caused an increase in the musculoskeletal activity and eventually results in overexertion and discomfort of muscles (Laursen et al., 2002). Psychosocial factors also have been reported to have a significant effect on reported musculoskeletal symptoms (Buckle, 1997). Zakerian and Subramanian (2011) found a significant relationship among psychosocial work factors, work stress and musculoskeletal discomfort.

4.7.5 Relationship between work environment and upper extremity musculoskeletal discomfort

This study revealed that no positive relationship was found between work environment (work station and study environment) and upper extremity discomforts. However, other studies conducted by Halpern and Davis (1993) pointed out that poor workstation design and layout are common factors where 64% of the sample rated at least one aspect of the workstation was poor. They also reported that 57% of those participants who responded to the survey experienced minor or moderate pain in at least one body part. In other study , sample dissatisfaction with their workstation layout was associated with prolonged neck pain (Andersen, Harhoff, Grimstrup, Vilstrup, Lassen, Brandt et al., 2008) and with elevated risk for carpal tunnel syndrome (Andersen, Thomsen, Overgaard, Lassen, Brandt, Vilstrup et al., 2003). Study done by Sillanpa et al. (2003) found that employees' perception that their workstations was not ergonomically set-up was strongly associated with increased prevalence in musculoskeletal discomfort. However this study finding was otherwise because the respondents found that their workstation was fairly ergonomics and the work environment was only sometimes not conducive. They were generally had no issues on ergonomics factors. To the researchers, “dissatisfaction with workstation” might mean the level of comfort of the chair, the height of the desk, the tilt of the computer screen and etc. however, the respondents might interpreted it as his/her satisfaction with the computer itself, the location of the desks or the lighting level. Such discrepancies in interpretations might probably contribute to insignificant finding.

It is also possible that this study sample was too young to have developed significant musculoskeletal problems. In my opinion, different result might be found in a group of older respondents who have more years of exposure to computer. However, there are no studies being done to compare between office workers and students. This explanation would need support in a form of longitudinal studies. Diversity in terms of age, longitudinal studies with larger samples would assist in establishing relationship between various risk factors and musculoskeletal disorders.

4.7.6 Relationship between history of musculoskeletal symptoms and upper extremity musculoskeletal discomfort

The result revealed that there was a positive relationship between upper extremity musculoskeletal discomfort and history of musculoskeletal symptoms, where $r = 0.337$, $n = 130$, $p < 0.05$. From the study conducted, 25.4% of respondents were referred to physician due to upper extremity pain and they were treated conservatively with physiotherapy and medication. Among the history of symptoms related to upper extremity discomforts: 63.8% feel fatigue and exhaustion in my upper musculoskeletal extremity, 58.5% feel stiffness in their fingers, 46.2% feel numbness in their finger, 20.0% feel tingling in their fingers, 17.7% feel weakness in their upper musculoskeletal and 6.2% suffer swelling in their hands. Generally, the respondents had experienced certain symptoms related to upper musculoskeletal discomfort. Majority experienced fatigue and exhaustion in upper extremity, followed by stiffness then numbness among the respondents. Review of the literature has demonstrated an increase in risk for development of neck pain associated with prior history of musculoskeletal pain (Côté et al., 2009). The available evidence suggests that a history of musculoskeletal symptoms at upper extremity region can increase the risk of upper extremity discomforts. It was found that experiencing neck pain in the past and history of low back ache increased the risk of developing neck pain in an adult general population (Croft et al., 2001; Hogg-Johnson et al., 2009).

4.7.7 Relationship between body regions complaints and upper extremity musculoskeletal discomfort

As for complaints at upper extremity, the result also found that there was a positive relationship between upper extremity musculoskeletal discomfort and previous body region complaints in upper extremity region where $r = 0.546$, $n = 130$, $p < 0.05$. It is also found that experiencing neck pain in the past and back pain increased the risk of developing neck pain in an adult population (Croft et al., 2001; Hogg-Johnson et al., 2009). Smedley at al. 2003 also reported similar findings among population of nurses, where the risk of developing neck or shoulder pain was increased in those who had previous pain or complaints within the neck/shoulder or low back. A Study by Smith and Leggat (2004) revealed that 80 percent of Australia nursing students reported an MSDs at some body site. Another study by Jenkins, Menendez, Amick, Tullar, Hupert, Robertson et al. (2007) reported that the regions with the highest prevalence of pain were the neck (72%), shoulder (56%) and wrist (51%). Similar findings were found by Schlossberg et al. (2004) where 60 percent of engineering graduate students reported recurrent or persistent upper extremity or neck pain related to computer use.

4.7.8 Risk factors that influenced upper extremity musculoskeletal discomfort

The six independent variables (body posture, work environment, psychosocial, break time, body region complaints and history of musculoskeletal symptoms) were significantly explained the variance in dependent variable (upper extremity musculoskeletal discomfort). Multiple regression analysis indicates that 32.7 percent of variance in upper extremity musculoskeletal discomfort was accounted for by the six independent variables. Further, of the six dimensions of independent variables, only complaints about musculoskeletal discomfort and psychosocial were significant predictors of upper extremity musculoskeletal discomfort.

The fact that only 32.7 % of the variance (R-square) in upper extremity discomfort has been significantly explained by the six independent variables in this study leaves 67.3 % to be explained. In other words, there are other additional variables that are important in explaining the upper extremity discomfort that have not been considered in this study. So further research might be necessary to explain more on the variance in upper extremity discomfort. For example anthropometric measurement and ergonomics measurements as in Gray (2011) study. Diversity in terms of age, longitudinal studies with larger samples would assist in establishing a causal relationship between various risk factors and musculoskeletal disorders. Many studies indicated that the relationship between psychosocial work actors, work stress and musculoskeletal discomfort could not be successfully examined in cross sectional study (Bongers et al., 1993; Sauters et al., 1996), therefore the relationship among these factors should be examined over a period of time. Bongers et al. (1993)

recommended using longitudinal study when studying this matter. Sauter and Swanson (1996) agreed with this suggestion. According to Bongers et al. a cross sectional study did not allow the examination of causality, whereby in a longitudinal study where collected over time, symptoms could be measured.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This study reiterates the previous findings that upper extremity is a common phenomenon among young adults especially college students (Lorusso et al., 2009; Menendez et al., 2009). Several researches that had been conducted among adults working in offices in Malaysia concluded that computer use is a risk factor in developing musculoskeletal problems (Rahman & Atiya, 2009; Zakeria and Subramaniam, 2011). However, there is little knowledge on the prevalence of musculoskeletal complaints among college students in Malaysia using computers. In summary, many studies have investigated the relationship between computer use and musculoskeletal discomforts in various populations; nevertheless, such research is limited in the samples of college or university students. The current study aimed to fill the gap. The findings support the overall conclusion that the aetiology of musculoskeletal discomforts is likely to be dependent not only on the presence of an individual risk factor, rather, on a combination and interaction of them.

5.2 Summary of key findings

There have been a range of studies, as mentioned earlier, supporting and refuting the hypotheses that computer use related to upper extremity musculoskeletal discomforts. This study has shown that four of the hypotheses were substantiated and these were consistent with other studies as mentioned in earlier chapter. There were positive relationship between body postures, psychosocial factors, history of musculoskeletal symptoms, body region complaints and upper extremity musculoskeletal discomfort. These findings have shown that body postures, psychosocial factors, history of musculoskeletal symptoms, body region complaints are risk factors for developing upper extremity musculoskeletal discomfort among students who use computer on regular basis. However, two hypotheses were not substantiated i.e. break time of computer usage and work environment. There were no positive relationship between break time of computer usage and upper extremity musculoskeletal discomfort as well as work environment and upper extremity musculoskeletal discomfort. This study findings were otherwise because the respondents found that their workstation was fairly ergonomics and the work environment was sometimes conducive. They were generally had no issues on ergonomics factors. As for break time, no positive relationship was found probably due to majority 82.3% of the respondents spent less than 6 hours daily on computer and they have a break when using the computer. A study by Cook et al. (2000) also found no association between total hours of computer use and musculoskeletal symptoms. Caution needs to be taken when considering the accuracy of reported work hours, as self-reports of computer work hours have been found to be overestimated (Faucett and Rempel, 1996) or unreliable (Marcus and Gerr, 1996). Among the six risk factors that predispose to upper extremity musculoskeletal discomfort, only body region complaints and psychosocial were found to significantly influenced the development of upper extremity musculoskeletal discomfort.

As musculoskeletal pain has become a global public health issue in view of its high prevalence and large economic burden, service sector oriented work has increased which emphasize on the use of computer, therefore it is imperative for us to create the awareness on the impact of computer use in long run. Unfortunately, there is minimal information on the risks associated with computer use in terms of detrimental musculoskeletal outcomes. The target groups for this campaign are educational institutions and service sectors. This is because some educational institutions have focused on the daily use of technology and implemented laptop based education and service sectors spend most of their working time dealing with computers.

Hopefully, this study helps to create the awareness and the necessary action taken by the government, institutions and individual to prevent the development of upper extremity musculoskeletal discomforts related to computer use in near future.

5.3 Limitations

Ergonomically designed and adjustable computer workstation, chairs, keyboards and mouse are highly and easily available to this population. Carter and Banister, (1994) and Schlossberg et al. (2004) have demonstrated that adjusting work surface height and chairs and using ergonomic keyboard help alleviate musculoskeletal discomfort. It is possible that this study sample was using one of these ergonomic tools. Unfortunately, this information was not asked. Hence, this study did not find any association between ergonomic factors and upper extremity discomforts probably the college used ergonomic tools.

The lack of objective data was another limitation of this study, as it relied on student self-report of both risk factors and upper extremity discomfort and it is well-known that such data are always not reliable. Obtaining objective measurements of the duration of use computer, break time etc. would be useful in the future. In addition, the level of discomfort experienced and reported by the individual was purely subjective, as we have various thresholds of pain. Therefore, objective or more physiologically based managements of pain may also help achieve more accurate results in future studies.

The sample consists of mostly male respondents as the college has more male students compared to female. Therefore, we could not make comparison between male and female pertaining to upper extremity musculoskeletal discomfort related to computer use. The respondents were majority less than 30 years old. Diversity in terms of age, longitudinal studies with larger samples would assist in establishing a causal relationship between various risk factors and musculoskeletal disorders. Comparison among different university cannot be done due to time constraint. In future it is good to conduct studies among different universities to identify the trend of MSDs among students.

Cross-sectional study is useful for establishing exposure disease associations, in this case providing direction for future research pertaining to this matter. The limitations associated with cross-sectional studies of musculoskeletal symptoms have been well documented. These include the inability to establish a temporal relationship and to trace exposure over time. The use of questionnaires, which rely on symptom reporting can overestimate the magnitude of the problem as the presence of symptoms do not equate with prevalence of musculoskeletal disorders (Cook et al., 2000). Another limitation is that very limited research on musculoskeletal discomfort related to computer use among college or university students. Most of the study was done among office workers. Furthermore, only certain risk factors related to computer use are being investigated. Other factors such as anthropometric are not included as it involves man power and time consuming.

In this study, no differentiation between desktop and laptop computers use were made although there are obvious differences between the way a desktop and laptop computer are used. For instance, desktop workstations are adjustable and used largely by workers in the office whereas laptop computers are used by students in crowded lecture halls where the seats and desks height cannot be adjusted. Furthermore, student's laptop users in general do not use the key board, mouse and monitor as compared to desktop computer. In view of this, it can be concluded that laptop users are vulnerable to postural stress. Probably future study can differentiate between desktop and laptop contributions to MSDs.

Another limitation is the definition of musculoskeletal discomfort. Definition used in this current study may differ from that used in other studies. Therefore, direct comparison of the prevalence is not an easy task. Apart from that, outcome of musculoskeletal in the current study was not confirmed with physical examination to verify the claim of self-reported symptoms. Recall bias in determining information regarding symptoms is another limitation. Respondents who recently had symptoms may provide better information as they are more likely to remember the symptoms. Thus, for the study to be more conclusive, it is suggested that a future research should consider taking a clinical history of each subject as well as perform a medical examination to confirm the symptoms.

5.4 Recommendation

Laptop computer use is on the rise, particularly within educational institutions, being use by 93.8% of students in our study. Jacobs et al. (2009) mentioned that 75.8% of the students used laptop computer in their survey in 2007. This is coupled with an increase in laptop ownership, increasing from 66% in 2006 to 88% in 2009 (Smith et al., 2009). With such a trend it is clear that research on the risks of developing MSDs due to laptop use is imperative among this demographic. In a student population, risks factors are magnified due to the nature of their work environment. Furthermore, there have been a range of studies supporting and refuting the hypothesis on the relationship between upper extremity musculoskeletal discomfort and computer use. Therefore, more research on this issue is strongly recommended.

It is advocated to use ergonomic furniture and computer equipment to avoid or minimise MSDs among college and university students. Students generally reported more frequently upper extremity discomfort than the professionals. Frequent assumption of awkward postures was associated with frequent discomfort. The findings signal a need for intervention, including training and education, prior to entry into the workforce. Students are future workers and so it is important to determine whether their increasing exposure to computers, prior to entering the workforce may make it so they already injured or do not enter their chosen profession due to upper extremity MSDs.

Figure 5-1 shows the correct ways to use computer in order to avoid MSDs among computer users. It is recommended by Singapore General Hospital Occupational Therapy Department.

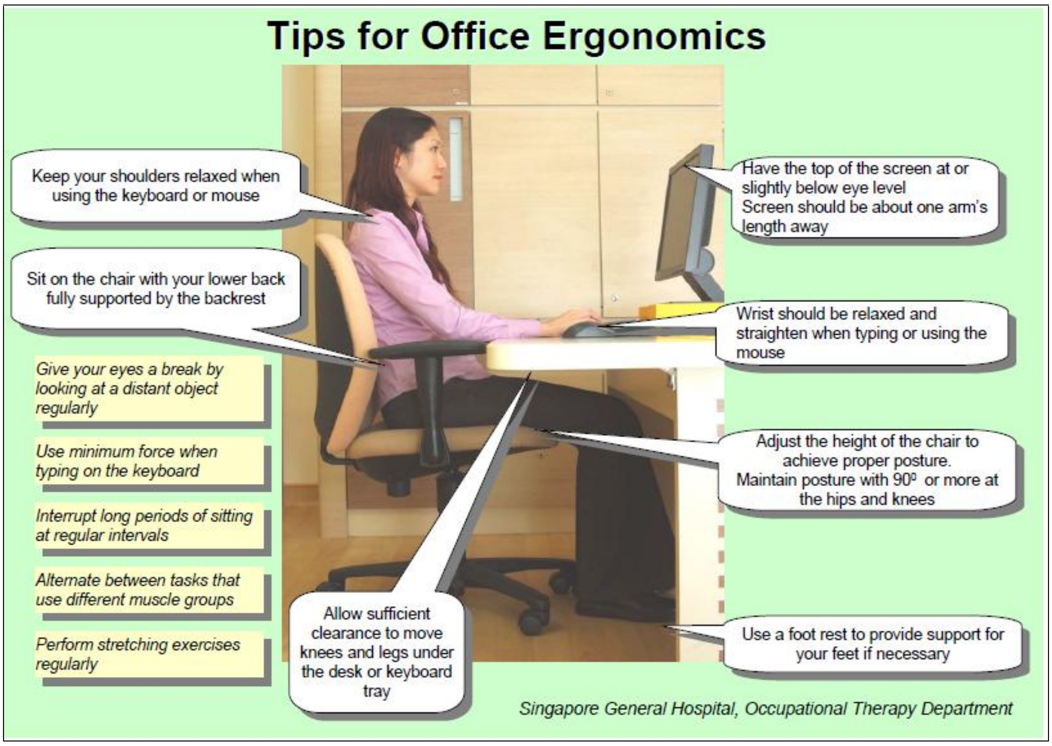

Figure 5-1.
Tips for Office Ergonomics. Adapted from Singapore General Hospital Occupational Therapy Department (2012)

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