A COMPARISON OF MALE VERSUS FEMALE UOIT STUDENTS WHO USE ELECTRONIC OR DIGITAL DEVICES AND TECHNOLOGIES WITH A VIDEO DISPLAY TERMINAL AND ASSOCIATED NEGATIVE HEALTH OUTCOMES EXPERIENCED

By

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ABSTRACT

Aims and Significance

Electronic and digital device and technologies use with Video Display Terminals (VDTs) has increased exponentially. There are negative health effects associated with their use. This study compares VDT use between the sexes and assesses the relationship between VDT exposure and associated potential negative health effects.

Methods

A cross-sectional study was employed using self-reported questionnaires to explore the negative health effects associated with VDT use. 278 undergraduate University of Ontario Institute of Technology (UOIT) students in participated in the study of which 65.8% were females (aged between 17-30 years) and 34.2% were males (aged between 18-30 years).

Results

Female UOIT students reported more pain in the neck/shoulder/hand and eye discomfort and headaches/migraines in comparison to their male counterparts.

Conclusion

This study provide preliminary evidence to suggest that female UOIT students experienced increased negative health effects on exposure to VDTs in comparison to their male counterparts.

KEY WORDS: VDT and health, VDT and eyestrain, VDT and psychosocial effects, Internet addiction

DEDICATION

I would like to dedicate this work to my wife Nadira and my kids Zayeed, Muadh and Hudhaifah.

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Chapter 1

General Introduction

General Introduction

Video display terminals (VDT) are defined as any computer-based output surface and projecting electronic or digital-based device or technology that is capable of projection images, photos, film, text or other forms of information via a cathode ray tube (CRT), liquid crystal display (LCD), light-emitting diode, glass plasma or other forms of image projection technologies**.** Examples of VDTs include computers, laptops, electronic notebooks, tablets, and a variety of portable cellular phones and devices (e.g., Blackberrys, iPhones, smartphones) (World Health Organization, 2010; WhatIs, 2011). The use of electronic and digital devices and technologies with VDTs have increased exponentially in the past few decades in both developed and developing nations around the world.

Statistically, Asia has 44% of the world's Internet users, followed by Europe (21%) and then North America (11.4%). Internet use has experienced considerable growth between 2001-2012; the Middle East experiencing the biggest growth (2,639.9%), followed by Latin America (1,310.8%) (Internet World Stats, 2013).

In Canada and other developed and industrialized nations in the world (e.g., UK, EU, USA, Australia) accessing the Internet via VDT-based devices has become the primary means of communication, accessing and sharing information, and entertainment (e.g., Klussman et al., 2008; Kormas et al., 2011; Travers & Stanton, 2002; Lin, Feng, Chao & Tseng, 2008; Yoo and An, 2009). In recent years, laptops have become the medium of choice for millennial university students, growing from 65.9% in 2006 to 82.2% in 2008 (Salaway, Caruso & Nelson, 2008).

In 2008 alone, over 66.1% of the students owned portable phones with Internet capabilities. These students spent an average of 19.6 hours per week online doing activities related to work, school or recreation. It has been estimated that 45% of youth and young adults are online every day in North America and as of July, 2010 Canada had the world's greatest number of Facebook users in proportion to its population; the United Kingdom was second and the USA was third (CEFRIO, 2010; O'Neil, 2012). For these students technology is more about communication and staying connected with their peers. Similarly, Lenhart (2009) reported that mobile cellular phone use has also steadily increased over the past decades. For example, since the year 2004 the number of cellular phones used by teenagers aged 12-17 years has increased from approximately 63% in 2006 to 71% in early 2008, and approximately 85% of adults surveyed reported that they owned at least one cellular phone in 2009 (Lenhart, 2009). It is predicted that by 2013 there will be over 6.9 billion subscribers and approximately 18% of those subscribers will be using smartphones (approximately 1.3 billion people) and by 2017, approximately 45% of mobile phone users will access WiFi (Wansink, Budde, Bibolini, Evans, Kwon, Lancaster, Lange & McNamara, 2013).

"*Nomophobia*" is defined as a disorder characterized by a pathological fear with high levels of stress and anxiety, which may also manifest as physical signs and symptoms (e.g., palpitations, increased perspiration, gastro-intestinal complaints) that result from being out of contact with an Internet-based provider via a mobile electronic or digital device such as a cellular phone, tablet, iPod, or computer. King, Valença and Nardi (2010) note that nomophobia appears to be a growing public health concern among individuals who have developed a compulsive-like dependence with technology and a pathological fear of not having access to Internet-based technologies. Similarly, Yildrim (2014) classified nomophobia as a situationally phobia having four dimensions; (i) inability to communicate; (ii) loss of connection (iii) losing access to information and (iv) giving up convenience.

Dixit et al. (2010) reported that over 18.5% of students between the ages of 17-28 years have a statistically significant nomophobia score of more than 24 (nomophobia scale, 20-24 = at risk of nomophobia). Approximately, 73% of students in that study reported having a mobile phone upon them even while sleeping. Bhatia (2008) argues that nomophobia is one of the symptoms of mobile phone addiction that warrants its inclusion in the Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V). Given that college and university students are frequent users of mobile devices and technologies (e.g., cellular and smart phones, tablets, laptops), and routinely use and access the Internet, there are growing public health concerns related to possible acute and chronic negative health effects associated with exposure to these devices and technologies with VDTs (Health Canada, 2006; Smith, Raimi & Zickuhn, 2011; Statistic Canada, 2011; Travers and Stanton, 2002).

Thomée (2014) reported that prolonged exposure to information and communication technology was found to be associated with increased mental stress and depressive symptomatology. Particularly, intensive email/chat use during leisure times was associated with increased self-reported sleep disturbances affecting both sleep quality and quantity.

Indeed, there is a growing body of evidence to suggest that exposure to these noted mobile devices and technologies with VDTs result in negative physical and psycho-social outcomes including increased stress and anxiety; sleep disturbances; muscle pain and discomfort (i.e., neck, shoulder); eye strain; headaches; nausea; restlessness; loneliness, and isolation (e.g., Balci & Aghazadeh, 2003; Hsu & Wong, 2013; Kormas et al., 2011; Nakazawa et al., 2003; Tomei et al., 2006; Yoo and An, 2009).

Although no causal link have been established between the use of cell phones and associated negative health effects, a recent systematic review conducted by Roosli, Frei, Mohler and Hug (2010) for the World Health Organization (WHO) shows an increasing level of concern over the continued use of advanced technology such as the Universal Mobile Telecommunications Systems (UTMS). Although the evidence is conflicting with regard to the negative effects of cell phone use, some studies suggested an association between headaches and exposure to UTMS signals. Other studies suggested increased fatigue in Mobile Phone Base Station (MPBS) exposure by individuals (Abdel-Rasool, Abou El- Fateh, Abou Salem, Michael, Farahat, El-Batanouny & Salem, 2007). Particularly, with regard to long-term effects of exposure to UTMS and Mobile Phone Base Stations (MPBS), there is not enough evidence to rule out negative health outcomes. Similarly, there was no association between brain tumors and mobile cellular phone use nor was there an association between exposure to radiofrequency fields (RF fields) and genotoxicity to brain cells according to a systematic review conducted by Repacholi et al. (2012).

The **target population** for this study are millennial (also known as Generation Y) male and female university students at University of Ontario Institute of Technology (UOIT) in Oshawa, Ontario. Millennials are defined as anyone born between 1981 and 2000. They are capable of understanding the nuances of digitization within all sectors of industry and the mass and social media that affect modern society. Currently, there is a dearth of investigations that have examined the relationship between electronic or digitally-based mobile devices and technologies (e.g., cellular phones, tablets, iPods, laptop computers) with VDTs and their potential health effects on college or university-aged young adults who are high users of these noted devices and technologies. This study seeks to fill these gaps in the empirical literature by focusing on Canadian university students as high users of technology, and by assessing the relationship with respect to exposure times and signs and symptoms manifested due to exposure to a variety of mobile electronic and digital devices with VDTs.

Accordingly, the aim of this thesis was to examine the relationship between the potential health effects and associated use and/or exposure to mobile electronic or digital devices and technologies with a video display terminal (VDTs) (e.g., laptops, cell phones, tablets, iPods) by undergraduate university students in Oshawa, Ontario, Canada.

Chapter 2 provides the reader with a detailed review of the literature with respect to the health effects associated with the use of and exposure to electronic or digital devices with a VDT.

Chapter 3 details the design and methods that was employed to examine the health effects associated with VDT use. This study employs a self-reported demographic and health questionnaire to elicit information related to exposure to a variety of mobile electronic and digitally-based technologies and devices that are equipped with VDTs (e.g., cellular phones, laptops), and various health related conditions and disorders (e.g., neck and shoulder pain, carpal, stress and anxiety, sleep disturbances).

Chapter 4 provides the reader with data analysis and results. Descriptive statistics are presented in graphic or tabular form. Descriptive statistics analyzed include means, standard deviations and ranges and inferential statistics will use Chi-Squared tests, Pearson Correlation, ANOVA and step-wise multiple regression analysis.

Chapter 5 provides the reader with conclusion and discussion. The implications of the findings in the light of each hypothesis are critically examined.

Chapter 2

Review of Literature

Systematic Review of Literature

Methods and Data Abstraction

Peer-reviewed articles were located by searching PUBMED, Google Scholar and Internet-based databases (e.g., Cochrane, PsychInfo). The inclusion criteria for these computer-based searches included the following: (i) Peer-reviewed journals published in English only; (ii) search dates were from January, 2002 to October, 2012; (iii) studies were limited to human quantitative or mixed-design methodologies/ approaches only; (iv) both the abstract (structured or unstructured) and full article had to be available for review; (v) the primary key terms included in the searches were VDTs and health, and (vi) secondary key terms included carpal tunnel syndrome, headaches, insomnia, eye and muscle strain. The exclusion criteria for these computer based searches included: (i) Non-English publications; (ii) studies that employed animal research models or cell lines (e.g., *in vitro* or *in vivo*); (iii) purely qualitative research investigations or approaches, and/or (iv) editorials or letters to the editor. Once the primary articles were located, they were read for appropriateness and their reference lists were also consulted to locate potential additional secondary references for review.

Appendix A provides the reader with a summary of systematic review. In brief, the primary source yielded 26858 potential articles, and when the inclusion criteria were applied, a total of 11499 potential articles were located during screening. The total number that met all required criteria were 104, and when duplicates were excluded, 37 articles remained for the systematic review. These 37 articles were located and are classified according to the health effects or outcomes observed. Twenty-eight of the articles were ranked IV, one was ranked III seven were ranked II and one was ranked VI. The following is a brief description of the rankings related to research designs. Rank 1 is the highest in the hierarchy of evidence and it includes systematic review of the randomized control trials. Rank II includes a single randomized control trial or non-randomized trial. Rank III includes systematic reviews of observational and/or correlational studies. Rank IV consists of a single observational or correlational study. Rank V includes systematic reviews of descriptive or qualitative studies. Single physiological, descriptive or qualitative studies are classified as Rank VI. Rank VII is the lowest ranking and it consists of professional opinions, panels/reviews or committee of experts (Bartfay & Bartfay, 2014). This ranking system mirrors the Cochrane Collaboration systematic review criteria.

VDT use and low back pain

Two studies identified the effects of VDT use on the lower back (e.g. Pillastrini et al., (2010); Das and Ghosh (2010). Pillastrini et al., (2010) examined the relationship between lower back pain and VDT use using a Rapid Entire Body Assessment (REBA) method. This method uses Action Level (AL) scores as an index for measuring musculoskeletal risk and urgency. The researchers found that there was a reduction in lower back pain when an ergonomic intervention was introduced.

Das and Ghosh (2010) suggested that prolonged VDT use is associated with an increase in the incidence of musculoskeletal discomfort primarily in the upper extremities as well as the lower back among male and female VDT users. They reported that this may be associated with prolonged awkward positioning while engaged in VDT work. Their study suggests that the most common complaint among VDT workers is lower back pain and neck pain.

Table 2.1 below shows exposure to VDTs and lower back pain in two studies. These studies individually reported a negative effect of VDTs on lower back pain. Taken together, these findings suggest that exposure to VDTs for prolonged periods increases the probability of compaints of back pain.

Table 2.1: Exposure to VDTs and Low Back Pain

Author(s) year, country	**Research design/methods**	**Ranking**	**Major findings**
Das & Ghosh (2010), Nepal	Survey design, N=100; 50 males and 50 females with < 5yrs of work experience; Tools=modified Nordic Musculoskeletal Questionnaire; Student's t-test, Chi-Sqared Test	IV	VDT operators who work hand intensive jobs have a higher rate of pain in the upper extremities. This study also suggests that females suffer discomfort more than their male counterparts and appear to have a higher rate of repetitive strain injury. The maximum discomfort suffered by the VDT workers was in the area of the neck and shoulder. This study also showed Lower Back pain to be one of the main areas of the body affected by prolonged VDT work. Along with musculoskeletal discomfort this study also suggests that visual stress or discomfort is a commonly reported symptom among VDT workers
Pillastrini et al. (2010) Italy	Quasi-Experimental, N=200, administrative employees, Tools=Ergonomic Brochure, Ergonomic adjustment of VDT workstation; Student's t-test, Wilcockson's rank-sum test, Chi-Squared test or Fisher's exact test, multinomial logistic regression model	II	Rapid Entire Body Assessment (REBA) scores and Lower Back Pain (LBP) point prevalence decreased over a period of 6 months. 49.5% of participants showed a decreased level of AL(Action Level) scores-an index of the level of musculoskeletal risk and urgency after the ergonomic intervention

Legend: N=2; VDT=Video Display Terminals; REBA=Rapid Entire Body Assessment; LBP=Low Back Pain; AL=Action Level

VDT use and Carpal Tunnel Syndrome-like Symptoms

Table 2.2 shows key studies associated with VDTs and Carpal Tunnel-like symptoms. Hou, et al., (2007) examined carpal tunnel syndrome-like symptoms in single male, college graduates working with VDTs within different departments of an information and communications company. Carpal tunnel-like symptomatology was found to be prevalent among 3.8% of the workers, and 3.7% of the workers had prolonged median nerve latency. Moderate job seniority (≈ 3-5 years) was associated with Carpal Tunnel Syndrome (CTS) (OR = 4.6).

El-Bastar, et al., (2011) reported that approximately 12.6% of their study participants had symptoms suggestive of median nerve neuropathy. Of the 12.6% that had these symptoms, approximately 33.3% were clinically confirmed as having CTS. Prevalence of CTS among VDT users was found to be 3.3%. Although the mean age in their study was higher (51.5 ± 7.2 years) when compared to other studies, they attributed this difference to the relatively new addition of VDTs in workplaces. Taken together, these studies suggest a link between VDT use and the development of CTS-like symptomatology in office workers.

Chandra and coworkers (2007) examined the effects of VDT work on static muscular strength that included hand grip; pinch grip; and back strength. They found that there was a difference in the maximum static forces and muscular fitness levels among different occupations. VDT workers had a higher incidence of exhibiting lower hand grip and pinch grip strength and had a higher incidence of back weakness, when compared to safety inspectors. These findings support other studies which suggest that jobs which involve excessive use of one’s hands, or inappropriate posture of the back, neck and shoulders (such as VDT work) are associated with a negative impact on muscular strength. These findings reported negative effects of exposure to VDTs with respect to upper extremity injuries.

Taken together, these findings suggests an increase in the incidence of carpal tunnel-like symptoms when exposed to VDTs.

Table 2.2-Exposure to VDTs and Carpal-tunnel like symptoms

Author(s) year, country	**Research design/methods**	**Ranking**	**Major findings**
Chandra et al., (2007), India	Quasi-experimental study design, N=45 males; 3 different occupational groups (VDT operators, Industrial workers, Safety Inspectors). Tools=Jamar handgrip dynamometer, Jamar pinchgrip, Back dynamometer; Kruskal-Wallis non-parametric one-way ANOVA	II	There is a statistically significant difference in the maximum static force and the level of muscular fitness in different occupations. Safety inspectors suffered the least in terms of hand grip strength (p=0.008), pinch grip strength (p=0.001) and back strength (p=0.001) when compared to VDT workers and Industrial workers
El-Bestar et al., (2011), Egypt	Cross-Sectional Study Design; N=95, 60 VDT users and 35 controls, Tools=Questionnaire, Electrophysiological tests, X-ray neck	IV	Neck-Upper extremity MSD was found to be more common in VDT users (28.3%) as compared to control group (14.3%). 12 out of 95 (12.6%) subjects had symptoms of median neuropathy and underwent electrophysiological testing, 4 out of the 12 (33.3%) had CTS. Mean age of MSD cases was higher than non-cases (51.5 +/-7.2 years and 42.8 +/- 9 years, respectively)

Legend: N=3; VDT=Video Display Terminals; ANOVA=Analysis of Variance; MSD=Musculo-Skeletal Disorder; CTS=Carpal Tunnel Syndrome

Author(s), year, country	Research design/methods	Ranking	Major Findings
Hou, Hsu,Lin, & Liang (2007), Taiwan	Cross-Sectional Study, N=82 young, single males, college graduates, Tools=Questionnaires, Hand diagram for Carpal Tunnel Syndrome, Physical exam, nerve conduction studies	IV	Prevalence of Carpal Tunnel Syndrome (CTS)-3.8%, prolonged median nerve motor latency 3.7%. Moderate seniority (3-5yrs) in work associated with CTS symptoms (OR=4.6), Increased BMI associated with increased CTS (OR=4.1)

Legend: N=3; VDT=Video Display Terminals; ANOVA=Analysis of Variance; MSD=Musculo-Skeletal Disorder; CTS=Carpal Tunnel Syndrome

VDT Use and Upper Extremity And Neck Symptomatology

A total of 16 studies were identified which examined the effect of VDTs on neck and upper extremity symptomatology (e.g. Balci & Aghazadeh, 2003; Dainoff & Dainoff, 2005; El-Bastar, El-Mitwalli and Kashaba, 2011; Hakala, et al., 2010; Hsu & Wang, 2003; Klussmann, et al., 2008; Seghers, Jochem & Spaepen, 2003; Fogleman & Lewis, 2002; Lyon, et al., 2003; Gerr, Marcus & Monteilh, 2004; Nakazawa, et al., 2002; Spallek, et al., 2010; Yoo & An, 2009; Ye, et al., 2007a; Travers & Stanton, 2002; Mirmohammadi, eta al., 2012). Table 2.3 shows the effects of exposure to VDTs on the neck and upper extremities.

These aforementioned studies showed that exposure to VDTs is associated with higher prevalences of neck and upper extremity pain and discomfort. Balci and Aghazadeh (2003) found that changes made in the work-rest schedule affected the severity of upper extremity discomfort. Notably, subjects who took routine breaks reported lowest levels of discomfort and also had the highest level of work performance related to data entry tasks. The researchers postulated that data entry tasks were much better suited to reduce upper extremity discomfort, in comparison to mental arithmetic tasks.

Dainoff, Cohen and Dainoff (2005) examined the effect of an ergonomic intervention on musculoskeletal, visual and psychosocial strain. Musculoskeletal symptom precursors (i.e. signs that upon physical examination determine future development of musculoskeletal symptomatology) such as trigger/pressure points, shoulder tests (i.e. mobility) and neck mobility (i.e. pain during neck flexion, extension, sideways flexion and rotation) were examined for changes. A decrease in trigger/pressure points post-intervention was observed as were increases in shoulder mobility and decreases in neck pain. Statistically significant decreases in intensity and frequency of pain were observed from the commencement of the study to 30 day post-intervention. Other parameters measured by the researchers, such as visual problems and psychosocial changes will be discussed in relevant sections below. Similarly, Mirmohammadi, et al., (2012) examined the effects of verbal ergonomic training program on work postures. The ergonomic training program included scientific information as well as a visual presentation (i.e. verbal training). Their findings suggested that there was a decrease in shoulder, neck, elbow, wrists and trunk pain following the completion of the training.

El-Bestar et al. (2011) found that the overall prevalence of neck/upper extremity musculoskeletal disorders (MSDs) among VDT users was higher (approx. 28.3%), when compared to the control group (approx. 14.3%). Prevalence of cervical spondylosis; cervical disc space narrowing, and cervical radiculopathy was also found to be higher among VDT users (18.3, 18.3 and 10%, respectively), when compared to controls (11.4 11.4 and 2.8% respectively). Neck-shoulder region musculoskeletal symptomatology was found to be more common among VDT workers.

Although the purpose of the study done by Hakala, et al. (2010) was to examine the effects of ergonomic instruction on computer related symptoms (i.e. headache, neck-shoulder pain and low back pain), it is clear from their findings that the most commonly reported symptoms involved the neck-shoulder and eyes. They found that using the computer for more than one hour daily, was associated with negative health symptoms in the upper extremities, which include the neck, shoulder, hands, fingers and wrists. There was a statistically significant relationship between neck-shoulder complaints and increasing computer use exposure time.

Hsu and Wang (2003) reported that the prevalence of neck-shoulder and upper extremity discomfort among VDT users was 42%. The prevalence rate of upper extremity and back discomfort was higher in full-time VDT users when compared to part-time users. Although this relationship is not confirmed, there appears to be a relationship between the exposure time to VDTs and an increase in the rates of discomfort among VDT workers. In addition, changes in height of the screens were associated with increases in neck/shoulder discomfort.

Klussman, et al. (2008) examined the relationship between VDT exposure and upper extremity and neck symptoms. Neck and shoulder symptoms were found to be more prevalent, when compared to hand/wrist or elbow/forearm symptomatology. The highest prevalence after a period of one year was found to be in the neck (55%) and shoulder (38%); followed by hand/wrist (21%), and lastly elbow/forearm (15%). A few contributing factors associated with musculoskeletal symptomatology were the number of years worked (>20); decreased job satisfaction; typing for > 6 hours/day, and limited amount of breaks. Specifically, typing for more than 6 hours/day had a significant impact on neck discomfort.

Seghers, Jochem & Spaepen (2003) examined the relationship between prolonged VDT work and its potential effects on head-neck posture; muscle activity, and muscle fatigue. Muscle activity was influenced by screen height, especially in the neck extensor muscles (NXT). Lowering the screen height was associated with increased NXT activity mostly due to flexion. The highest level of NXT activity was found to occur with the laptop use due to extreme flexion of the neck. In addition, they observed significant postural changes associated with changes in screen heights. Their study showed that there is significant change in the visual angle (VA), the eye-ear angle (EEA) and the relative visual angle (VArel) with laptop use. They found that there was an increase in VA and VArel associated with low monitor positions; whereas EEA decreased in this position. However, with time VA significantly decreased in all screen positions while there was no significant change in EEA except that a slight increase was observed with increases in screen height.

Fogleman and Lewis (2002) examined the relationship between occupational, non-occupational and demographic risk factors and musculoskeletal discomfort with VDT exposure. They found a consistent negative association between the number of hours worked and musculoskeletal discomfort. They suggested that there is increased risk of neck/upper back, lower back and shoulder discomfort if the monitor was placed too low resulting in a forward slouching by the individual. Placing the keyboard too low was associated with discomfort in all body regions except the lower back and shoulders. In addition, extension at the wrist was found to be a risk factor for the development of musculoskeletal disorders.

Gerr, Marcus & Monteilh (2004) conducted a systematic review which examined the association between musculoskeletal disorders (MSD's) and posture, as well as intensity of keyboard use. Posture was found to be an independent risk factor for MSDs among computer operators. Lowering the keyboard height at or below elbow level and resting the arms on the desk surface reduced the risk of neck and shoulder complaints. Certain studies suggested that over extending the wrist may have a significant impact on hand-arm MSD. Prevalence of MSDs, especially of the neck and shoulder, increased in a dose-dependent manner with the total number of hours spent typing on a keyboard. In addition, some studies suggested a doubling of hand/arm MSD risk with increased typing of more than 20 hours/week.

Nakazawa, and coworkers (2002), categorized subjective symptomatology into 3 categories: (i) Physical; (ii) mental, and (iii) sleep-related. Physical symptomatology was positively correlated with increases in the duration of daily VDT use. We shall explore additional relevant findings by Nakazawa et al., (2002) in the appropriate sections below.

Although Spalleck, et al. (2010) studied the type of work performed and its association with musculoskeletal symptomatology, they suggested an association between VDT work and increases in upper extremity and neck symptomatology. For example, when they compared blue-collar workers to white-collar workers they noted that disorders of the flexor tendons of the forearms were common among blue-collar workers and trainees, conversely, side-flexion and cervical rotation of the neck was most likely to be present in white-collar workers who assumed different VDT tasks. Similarly, Das and Ghosh (2010) suggested that VDT workers who perform hand intensive jobs have a higher rate of pain in the upper extremities of the body.

Yoo and An (2009) examined the relationship between cervical range of motion (ROM) and head/neck postural changes after continuous VDT work. There was an inverse correlation between the active neck extension angle, and the mean craniocervical angle. Moreover, a negative correlation was detected between active neck flexion angle and the mean cervicothoracic angle. After long-term work with VDTs, participants with limited range of motion (ROM) of neck extension were observed to exhibit changes in the craniocervical angles. Subjects with limited ROM of neck flexion were observed to exhibit a greater change in the cervicothoracic angle, suggesting that habitual shortening of the muscle length on a daily basis could cause adaptive changes in the muscle length as a result of adopting a habitual forward head posture. Head posture was associated with a change in cervical range of motion both in normal controls as well as in individuals suffering from neck discomfort/pain.

Ye and coworkers (2007a) examined the relationship between duration of daily VDT use and subjective symptoms such as eyestrain, neck or upper extremity pain, back pain and mental health. A significant relationship was found to exist between VDT use duration and the aforementioned symptoms. They postulated that increases in musculoskeletal symptomatology may have resulted due to restricted posture and static muscle load in addition to work load; demands of the job, and social support. Furthermore, the study examined the effect of breaks and rest periods during VDT work. The researchers found that a lack of breaks and rest periods during VDT work significantly increased the risk of developing eyestrain, neck or upper extremity pain, back pain in addition to a deterioration in mental health status (p-value <0.001).

Travers and Stanton (2002) examined the relationship between VDT use and psychological and physical symptomatology. While the researchers focused on other factors such as viewing distance and glare, they suggested that increases in neck pain could be due to the positioning of the neck while working with the VDT.

Lyon, et al., (2003) examined the relationship between VDT monitor placement and the number of hours female bifocal wearers spend in front of a VDT. Monitor placement with respect to height, distance and angle from the horizontal and the relationship to pain symptomatology was not found to be statistically significant. Nonetheless, their findings support the suggestion of negative physical health effects such as head/neck pain and shoulder/arm pain among VDT workers. They suggested that working on an average of > 5 hours/ day in front of a VDT is associated with head and neck/ shoulder or arm pain. These studies reported negative effects on the neck and upper extremities when exposed to VDTs. Taken together, there is evidence to suggest that exposure to VDTs increases the probability of neck and back pain injuries.

Table 2.3 Effects of Exposure to VDT on Upper Extremities & Neck

Author(s), year, country	**Research design/methods**	**Ranking**	**Major findings**
Balci & Aghazadeh (2003), USA	Randomized experimental design N= 10, males; College Students, Right-handed, Humming-Sligo procedure was followed in the analysis=Perform a multiple analysis of variance (MANOVA) and separate analysis of variance (ANOVA) tests were applied for each variable. Wilk's lambda was selected as the MANOVA test criterion	II	15/micro schedule was found to have the lowest discomfort in the neck, lower back and chest and highest performance, compared with 30/5 and 15/ micro schedules. Data entry task usually resulted in lowest upper extremity discomfort compared with mental arithmetic task. 30/5 work-rest schedule had lowest eye-strain and blurred vision along with the 15/ micro schedule. Mental arithmetic task resulted in the lowest eye-strain compared to Data Entry task. Data entry task participants performed faster, more accurately and had higher performance than those in the mental arithmetic. 15/ micro also resulted in higher speed, accuracy and performance compared to the other two schedules
Dainoff, Cohen & Dainoff (2005), USA	Quasi-Experimental study design, N=26, female employees of Cincinnati Service Center of the US Internal Revenue Service, age= 41.02 (SD=9.58), data entry clerks, mean number of years at work=15.71 (SD=6.55); 9 females married with children; 5 married with no children, 10 not living with another adult (8 of them had children). ; Tools=questionnaires, ergonomic redesign, follow up	II	Study found marked decrease in trigger points from commencement to 30 Day post-test overall *F* test, *Fr* =198.69,($p < .001$ for 26 subjects and 3 conditions); marked decrease in shoulder stiffness, increase in shoulder range of motion and decrease in pain following intervention (chi square (2 *df*)= 817.5, $p < .001$). Marked decrease in neck pain following intervention (chi square (2 *df*) = 429.4, $p < .001$). Decrease of

Author(s), year, country	**Research design/methods**	**Ranking**	**Major findings**
			intensity and frequency of pain/discomfort of neck, shoulder
El-Bestar, et al. (2011), Egypt	Cross-Sectional Study Design; N=95, 60 VDT users and 35 controls, Tools=Questionnaire, Electrophysiological tests, X-ray neck	IV	Neck-Upper extremity MSD was found to be more common in VDT users (28.3%) as compared to control group (14.3%). 12 out of 95 (12.6%) subjects had symptoms of median neuropathy and underwent electrophysiological testing, 4 out of the 12 (33.3%) had CTS. Mean age of MSD cases was higher than non-cases (51.5 +/- 7.2 years and 42.8 +/- 9 years, respectively)
Fogleman & Lewis (2002), USA	Cross-Sectional Study Design; N=292; males=51% age range=23-63 years (mean age=42.7 years; 81% white. Tools=Questionnaire, Exploratory factor analysis, Logistic regression	IV	Single most important risk factor identified for discomfort was-hours worked (for all body regions). Workstation position-monitor too low was found to be associated with increased body discomfort in the neck/upper back, lower back and shoulders; monitor too high was found to be associated with increase in headaches and eyestrain; keyboard too low was associated with discomfort in all body regions except for lower back and shoulders. Race (white) was associated with decreased in discomfort reported in shoulders, elbow/forearms and hand/wrist body regions.

Author(s) year, country	**Research design/methods**	**Ranking**	**Major Findings**
Gerr, Marcus & Monteilh (2004), USA	Systematic review of 21 articles examining association between posture and musculoskeletal outcomes among computer users as well as keyboard use and musculoskeletal outcomes	III	This review found that posture is an independent risk factor for MSDs among computer users. Locating the keyboard below elbow level or resting the arms on the desk surface was associated with a reduction in the risk of neck and shoulder MSDs. Increasing wrist extension increases the risk of hand-arm MSD; number of hours spent keying is associated with an increase in neck and shoulder conditions
Hakala, et al. (2010), Finland	Cross-Sectional Study; N=7292; boys aged 12 yrs=351;14 yrs=1251;16 yrs=892; 18yrs=774; girls aged 12 yrs=452; 14 yrs=1485; 16 yrs=1138; 18 yrs=976; Tools= Questionnaire; SPSS v. 11.0; Logical regression analysis	IV	Most frequently reported symptoms were in the eyes, neck or shoulders. One hour of daily computer use was found to be associated with increase in upper extremity symptoms (neck, shoulders, hands, fingers and wrists) 4 hours of more of daily use was associated with symptoms in all anatomical sites including eyes, head and lower back. No significant relationship between ergonomic instruction and increase in the level of reported symptoms. More complaints among girls than boys and prevalence increased with age. Statistically significant relationship found between computer use and eye and neck-shoulder discomfort. Risk of increase in symptomatology in neck-shoulder and upper extremity with increase in

Author(s), year, country	**Research design/methods**	**Ranking**	**Major Findings**
			computer use exposure time. No relationship was found between ergonomic instruction and health related complaints except for eye related symptomatology.
Hsu & Wang (2003), Taiwan	Cross-Sectional study design, N= 119, data-entry personnel=10, Programming engineers=40, CAD engineers=18, fabrication engineers=51, Tools= Questionnaire, Job Stress Scale (JSTS), Job Satisfaction scale (JSAS), multivariate logistical regression techniques	IV	Overall prevalence of upper extremity discomfort including neck, shoulder, upper arm, forearm/elbow, wrist and fingers was 42%. Full-time VDT users have higher prevalence rates of upper extremity discomforts than do part-time VDT users. This study could not confirm the association between length of VDT working time and increase in discomfort. This study reported increase in visual strain with shorter viewing distance; deviation of monitor height from the participants preferred position caused greater neck/shoulder discomfort. There was significant correlation between monotonous work and back discomfort among VDT users. This study also suggested that psychosocial factors are more predictive than physical and ergonomic factors for lower extremity discomforts in logistic regression models.

Author(s), year, country	Research design/methods	Ranking	Major findings
Klussmann, Gebhardt, Liebers & Rieger (2008), Germany	Cross-Sectional Study design; N=81, mean age (39.9 +/- 9.5 years) Tools= BiFra (German VDTquestionnaire), Questionnaire (Nordic Questionnaire), Psychosocial questionnaire (COSPOQ), physical examination, SPSS, logical regression analysis	IV	Neck and Shoulder complaints (55% and 38%, respectively) more than upper arm complaints and hand/wrist, and elbow/ forearm complaints (21% and 15% respectively). Women had complaints more than men of neck and shoulder musculoskeletal symptoms. Low, but significant relationship between job satisfaction and neck and hand/wrist symptoms observed. Typing more than 6 hrs/day at a VDT station had a significant impact on the prevalence of neck symptoms. Predictors include >20 years on the job, high lack of job satisfaction, typing > 6 hrs/ day and limitations to take breaks significantly increased the 12-month prevalence of one or more musculoskeletal symptoms
Lyon, J.L. (Jr.), et al. (2003), USA	Survey design, N= 606 female secretarial and administrative bifocal wearers, age 20-80; Tools=Questionnaire; Paired T test	IV	No statistically significant difference between the distance of the VDT from the eye as well as angle in those with pain and those without. Statistically significant difference between the mean number of hours worked in front of a VDT and reporting of pain. Those who worked > 5 hours/day reported statistically significant pain in the head /neck (p=0.003)/shoulder and arm regions (p=0.004)

Author(s), year, country	**Research design/methods**	**Ranking**	**Major Findings**
Mirmohammadi, et al. (2012), Iran	Quasi-experimental design, 70 office employees-9 males, 61 females; Tools=RULA (Rapid Upper Limb Assessment) method, Paired t test, Wilcoxon signed-rank test, Mcnemar test	II	There was statistically significant improvement in the RULA scores of shoulder (p=0.001), elbow (p=0.001), neck (0.001), wrist (p=0.001), & trunk (p=0.001) but no significant improvement in the foot (p=1.00)
Nakazawa, et al. (2002), Japan	Survey design, N= >25000; age 20-59, clerical workers, Tools=ANOVA	IV	Seventeen subjective symptoms divided into 3: Factor 1 (mental symptoms, Factor 2 (physical symptoms) and Factor 3 (Sleep-related symptoms), Cronbach's alpha was 0.7 for mental symptoms,); 0.5 for both physical & Sleep related symptoms, suggesting a relationship between duration of daily VDT use and physical symptoms, mental and sleep symptoms score was significantly higher for groups using VDTs>5 hrs/day
Seghers, Jochem & Spaepen (2003), Belgium	Randomized Controlled study design; N=16, 8 males and 8 females; 7 participants= history of musculoskeletal neck and shoulder symptoms, 9=no problems; 10 had glasses/contact lenses; Tools=17 in. Cathode Ray Tube (CRT), 15 in. Thin Film Transistor (TFT), EMG device	II	The Visual Angle (VA), Ear-Eye Angle (EEA) and the VArel (Visual angle relative to the Ear-Eye line) differed significantly between all screen height settings. VA and VArel increased with lower monitor positions while EEA decreased with the VDT screen in the low placement position. VA significantly decreased with time in the high, baseline and low VDT screen positions. No difference in the laptop condition. EEA increased only in the high monitor position. Highest contribution of gaze angle (38%) to the change in VA was found between baseline and low VDT screen heights; 50%

Author(s), year, country	**Research design/methods**	**Ranking**	**Major Findings**
			increase of NXT muscle activity with change in screen height from 15 cm above baseline to table height due to neck flexion. Highest and baseline screen heights showed low EMG activity in the right NXT muscle compared to laptop condition. Left NXT muscle showed low EMG activity between the highest and low and the laptop conditions. Largest increase in muscle activity was in the highest monitor position. Greater horizontal distance to the middle of the screen in the laptop condition contributed to eye discomfort
Spallek et al, (2010), Germany	Cross-sectional study design; N= 276; 67 blue collar workers; 42 males, age-38.5+/-10 years, 25 females, age-27.1+/-14.2 years, 209 white collar workers, Tools=physical exam, questionnaire	IV	Disorders of flexor tendons in forearms was most common among blue collar workers and trainees, whereas side-flexion and cervical rotation most affected in white-collar workers with different VDT tasks

Author(s), year, country	**Research design/methods**	**Ranking**	**Major Findings**
Travers & Stanton, (2002) USA	Cross-sectional study design N=46; mean age=26(range of 21-40), 30 VDT users and 16 non-VDT users.. Tools=Questionnaire, short version of Job Description Inventory (JDI), Profile of Mood States (POMS)	IV	Study found viewing distances had no effect on symptoms, large percentage of VDT users complained of being bothered by reflection and reported symptoms related to eye-fatigue and neck ache. With respect to Profile of Mood States (POMS) VDT users did not score highly on anxiety, depression, Fatigue, hostility or confusion scales
Ye, Abe, et al. (2007a) Japan	Survey Study design, N=3070, mean age=39.9 years. Tools= Questionnaire, GHQ-12 Questionnaire; ANOVA, Duncan's multiple range test to evaluate post hoc comparisons, Ch-Squared test, Cochran-Armitage test, Logistical regression, SAS software v.8.2	IV	Significant relationship was detected between daily VDT use duration and eyestrain, neck and upper extremity pain, back pain and increased GHQ-12 scores. Longer duration of VDT use ≥ 5 hrs. per day was associated with deterioration in mental health status. Lack of breaks and rest was significantly associated with increased risk of developing eyestrain, neck pain, upper extremity pain, back pain and increase in GHQ-12 scores

Author(s), year and country	Research design/methods	Ranking	Major Findings
Yoo & An (2009) Korea	Correlational study design;N=20; 6 males and 14 females; age=26-32 years; Tools= Cervical Range of Motion instrument (CROM), video camera	IV	Active neck extension angle was negatively correlated with the mean craniocervical angle ($r=0.84$, $p<0.01$) and active neck flexion angle was negatively correlated with mean cervicothoracic angle ($r=0.82$, $p<0.01$). This showed that after long term VDT work subjects with limited range of motion (ROM) of neck extension exhibit changes in the craniocervical angle and those with limited range of motion (ROM) of neck flexion exhibit larger change in cervicothoracic angle

Legend: N=16; ANOVA=Analysis of Variance; MANOVA=Multiple Analysis of Variance; MSD=Musculo-Skeletal Disorder; CTS=Carpal Tunnel Syndrome; JSTS=Job Stress Scale; JSAS=Job Satisfaction Scale; RULA=Rapid Upper Limb Assessment; CRT=Cathode Ray Tube; TFT=Thin Film Transistor; EMG=Electromyography; JDI=Job Description Inventory; POMS=Profile of Mood States; GHQ-12=General Health Questionnaire

Effect of VDT Exposure and Eye Symptomatology

Ten studies examined the association between VDT use and eye symptomatology such as dryness; blurring, and eyestrain (e.g. Balci & Aghazadeh, 2003; Hakala, et al., 2010; Hsu & Wang, 2003; Dainoff & Dainoff, 2005; Seghers, Jochem & Spaepen, 2003; Lin, Feng, Chao & Tseng, 2008; Travers & Stanton, 2002; Uchino, et al., 2011; Uchino, et al., 2011; Ye, et al., 2007a).

Balci and Aghazadeh (2003), reported that an individual's work-rest schedule had a significant impact on eyestrain and blurred vision, and that the 30 minute work/5 minute break (every 30 minutes) had the lowest impact on the aforementioned symptomatology. Similarly, other studies suggested that lack of breaks and rest periods during VDT exposure extending more than 4 hours/day may result in eyestrain (e.g. Hakala et al., 2010; Ye et al., 2007a). Hsu and Wang (2003) proposed that shorter viewing distance than usual is related to an increase in visual strain. By contrast, Travers and Stanton (2002) found that viewing distance had no effect on eye symptomatology. However, a large percentage of participants (64%) were bothered by reflections, and corresponding increases in the symptoms of eye fatigue were noted.

However, Seghers, Jochem and Spaepen (2003) reported a significant postural change observed ($p<0.01$) with changes in screen position. Specifically, there was a significant difference in visual angle [VA], eye-ear angle [EEA] and relative visual angle [VArel]. VA and VArel increased with lower screen height while EEA decreased. Increased time spent on the VDT in turn decreased VA, while EEA increased significantly ($p \leq 0.05$) in the high monitor position. A tendency toward eyestrain was found with laptop use. In contrast to the findings of Hsu and Wang (2003) and Travers and Stanton (2002), Seghers et al., (2003) postulated that eyestrain could be caused by several factors such as the small size of the laptop screen and a greater distance between the eyes to the centre of the screen. In addition, Fogleman and Lewis (2002) found that if the monitor was placed too high, there was an increased risk associated with the development of headaches and eyestrain.

Examining the effect of ergonomic intervention and visual symptomatology, Dainoff and Dainoff (2005) reported decreases in visual problems such as burning; fatigue; itching, and redness or double/hazy vision following the intervention which persisted for one year. Lin, Feng, Chao and Tseng (2008) investigated the effects of illumination by VDTs at work and its negative health effects associated with complaints related to visual fatigue and eye strain. The investigators found increases in visual fatigue associated with red and green lights; whereas white and yellow lights had no significant negative outcomes noted. In addition, the findings suggest that workers can achieve optimal visual acuity with blue lights, followed by white, red, and lastly green lights. Lastly, low lighting conditions were also found to induce visual fatigue in the subjects.

Uchino et al. (2011) found that the prevalence of dry-eye disease was significantly related to long durations of VDT associated work. Wearing contact lenses was found to increase the risk of being clinically diagnosed with dry-eye disease as well as severe symptoms of dry-eye disease in VDT workers. In addition Uchino and coworkers (2011) found that women were more prone to eye discomfort, (e.g. dry-eye disease) than men (2.1% and 7.9%, respectively). This difference was reported to be attributed to the following risk factors: Low BMI; past/current hypertension (in men); myocardial infarction (MI)/angina, and VDT use (in women). Table 2.4 below summarizes the effects of exposure to VDTs on the eyes and visual complications. These studies demonstrate that there is a negative effect on the eyes when exposed to VDTs. In sum, these studies suggest that in individuals exposed to VDTs for prolonged periods of time, there is an increased probability of experiencing eye strain or discomfort.

Table 2.4. Effects of Exposure to VDTs and Eye Strain

Author(s), year and country	**Research design/methods**	**Ranking**	**Major Findings**
Balci & Aghazadeh (2003), USA	Randomized experimental design N= 10, males; College Students, Right-handed, Humming-Sligo procedure was followed in the analysis=Perform a multiple analysis of variance (MANOVA) and separate analysis of variance (ANOVA) tests were applied for each variable. Wilk's lambda was selected as the MANOVA test criterion	II	15/micro schedule was found to have the lowest discomfort in the neck, lower back and chest and highest performance, compared with 30/5 and 15/ micro schedules. Data entry task usually resulted in lowest upper extremity discomfort compared with mental arithmetic task. 30/5 work-rest schedule had lowest eye-strain and blurred vision along with the 15/ micro schedule. Mental arithmetic task resulted in the lowest eye-strain compared to Data Entry task. Data entry task participants performed faster, more accurately and had higher performance than those in the mental arithmetic. 15/ micro also resulted in higher speed, accuracy and performance compared to the other two schedules
Dainoff, Cohen & Dainoff (2005), USA	Quasi-experimental study design, N=26, female employees of Cincinnati Service Center of the US Internal Revenue Service, age= 41.02 (SD=9.58), data entry clerks, mean number of years at work=15.71 (SD=6.55); 9 females married with children; 5 married with no children, 10 not living with another adult (8 of them had children). ; Tools=questionnaires, ergonomic redesign, follow up	II	Study found marked decrease in trigger points from commencement to 30 Day post-test overall *F* test, *Fr* =198.69,($p < .001$ for 26 subjects and 3 conditions); marked decrease in shoulder stiffness, increase in shoulder range of motion and decrease in pain following intervention (chi square (2 *df*)= 817.5, $p < .001$). Marked decrease in neck pain following intervention (chi square (2 *df*) = 429.4, $p < .001$). Decrease of intensity and frequency of

Author(s), year and country	Research design/methods	Ranking	Major Findings
			pain/discomfort of neck, shoulder
Hakala, et al., (2010) Finland	Cross-sectional study; N=7292; boys aged 12 yrs=351;14 yrs=1251;16 yrs=892; 18yrs=774; girls aged 12 yrs=452; 14 yrs=1485; 16 yrs=1138; 18 yrs=976; Tools= Questionnaire; SPSS v. 11.0; Logical regression analysis	IV	Most frequently reported symptoms were in the eyes, neck or shoulders. One hour of daily computer use was found to be associated with increase in upper extremity symptoms (neck, shoulders, hands, fingers and wrists) 4 hours of more of daily use was associated with symptoms in all anatomical sites including eyes, head and lower back. No significant relationship between ergonomic instruction and increase in the level of reported symptoms. More complaints among girls than boys and prevalence increased with age. Statistically significant relationship found between computer use and eye and neck-shoulder discomfort. Risk of increase in symptomatology in neck-shoulder and upper extremity with increase in computer use exposure time. No relationship was found between ergonomic instruction and health related complaints except for eye related symptomatology.

Author(s), year and country	**Research design/methods**	**Ranking**	**Major Findings**
Hsu & Wang (2003) Taiwan	Cross-sectional study design, N= 119, data-entry personnel=10, Programming engineers=40, CAD engineers=18, fabrication engineers=51, Tools= Questionnaire, Job Stress Scale (JSTS), Job Satisfaction scale (JSAS), multivariate logistical regression techniques	IV	Overall prevalence of upper extremity discomfort including neck, shoulder, upper arm, forearm/elbow, wrist and fingers was 42%. Full-time VDT users have higher prevalence rates of upper extremity discomforts than do part-time VDT users. This study could not confirm the association between length of VDT working time and increase in discomfort. This study reported increase in visual strain with shorter viewing distance; deviation of monitor height from the participants preferred position caused greater neck/shoulder discomfort. There was significant correlation between monotonous work and back discomfort among VDT users. This study also suggested that psychosocial factors are more predictive than physical and ergonomic factors for lower extremity discomforts in logistic regression models.
Lin, et al. (2008), Taiwan	Randomized controlled design N=10; 5 male and 5 female college students; Tools=Optec 2000 Vision Tester, Minolta CL-200 chroma meter, Minolta CRT chroma meter CS-100A, Lafayette Instrument Company Flicker Fusion System Model 12021, Intel Pentium desktop Computer, 17 in. color CRT	II	Visual fatigue more under red and green light. No effect with white and yellow light. Visual acuity significantly affected in red light, best under blue light followed by white, red and green. Low lighting found to induce visual fatigue as signified by decreased CFF thresholds.

Author(s), year country	**Research design/methods**	**Ranking**	**Major Findings**
	monitor with a display resolution 1024X768 pixels at a refresh rate of 70 Hz. , fluorescent lamp, questionnaire		Subjects could overcome insufficient lighting during VDT work and still maintain good visual acuity after an hour of work
Seghers, Jochem & Spaepen (2003), Belgium	Randomized controlled study design; N=16, 8 males and 8 females; 7 participants= history of musculoskeletal neck and shoulder symptoms, 9=no problems; 10 had glasses/contact lenses; Tools=17 in. Cathode Ray Tube (CRT), 15 in. Thin Film Transistor (TFT), EMG device	II	The Visual Angle (VA), Ear-Eye Angle (EEA) and the VArel (Visual angle relative to the Ear-Eye line) differed significantly between all screen height settings. VA and VArel increased with lower monitor positions while EEA decreased with the VDT screen in the low placement position. VA significantly decreased with time in the high, baseline and low VDT screen positions. No difference in the laptop condition. EEA increased only in the high monitor position. Highest contribution of gaze angle (38%) to the change in VA was found between baseline and low VDT screen heights; 50% increase of NXT muscle activity with change in screen height from 15 cm above baseline to table height due to

Author(s), year, country	Research design/methods	Ranking	Major Findings
			neck flexion. Highest and baseline screen heights showed low EMG activity in the right NXT muscle compared to laptop condition. Left NXT muscle showed low EMG activity between the highest and low and the laptop conditions. Largest increase in muscle activity was in the highest monitor position. Greater horizontal distance to the middle of the screen in the laptop condition contributed to eye discomfort
Travers & Stanton, (2002), USA	Cross-sectional study design N=46; mean age=26(range of 21-40), 30 VDT users and 16 non-VDT users.. Tools=Questionnaire, short version of Job Description Inventory (JDI), Profile of Mood States (POMS)	IV	Study found viewing distances had no effect on symptoms, large percentage of VDT users complained of being bothered by reflection and reported symptoms related to eye-fatigue and neck ache. With respect to Profile of Mood States (POMS) VDT users did not score highly on anxiety, depression, Fatigue, hostility or confusion scales
Uchino, et al. (2011), Japan	Cross-Sectional Study, N=2644, (1221 males,1423females), age > 40 years, Tools=Questionnaire	IV	Clinical Diagnosed DED-2.1% males and 7.9% females. Severe symptom prevalence-11% males, 18.7% females, Combination of clinically diagnosed DED and Severe DED symptoms were 12.5% males and 21.6% females. Low BMI, past/current HT risk factors for DED in men, while MI/angina and VDT use risk factors in women. Contact lens was a risk factor for DED

Author(s), year and country	**Research design/methods**	**Ranking**	**Major Findings**
			in both men and women (men more than women-OR=3.84 & 3.61, respectively)
Uchino, et al. (2011), Japan	Cross-sectional Study design, N=4393, Tools=questionnaire, Statistical software	IV	DED commonly found in VDT workers among males and females; prevalence was more in females 21.5% as compared to males 10.1%. Severe DED was found to be 48% in females and 27.3% in males. Longer duration of VDT use was observed to be a significant trend toward a high prevalence of DED symptoms. Contact Lens wear was a major risk factor related to clinically diagnosed and severe symptoms of DED in VDT workers

Author(s), year, country	**Research design/methods**	**Ranking**	**Major Findings**
Ye, et al. (2007a), Japan	Survey Study design, N=3070, mean age=39.9 years. Tools= Questionnaire, GHQ-12 Questionnaire; ANOVA, Duncan's multiple range test to evaluate post hoc comparisons, Ch-Squared test, Cochran-Armitage test, Logistical regression, SAS software v.8.2	IV	Significant relationship was detected between daily VDT use duration and eyestrain, neck and upper extremity pain, back pain and increased GHQ-12 scores. Longer duration of VDT use ≥ 5 hrs. per day was associated with deterioration in mental health status. Lack of breaks and rest was significantly associated with increased risk of developing eyestrain, neck pain, upper extremity pain, back pain and increase in GHQ-12 scores

Legend: N=10; VDT=Video Display Terminals; ANOVA=Analysis of Variance; MANOVA=Multiple Analysis of Variance; JSTS=Job Stress Scale; JSAS=Job Satisfaction Scale; VA= Visual Angle; EEA= Ear-Eye Angle; VArel =Visual angle relative to the Ear-Eye line; NXT=Neck Extensor muscles; EMG=Electromyograph; POMS=Profile of Mood States; JDI=Job Description Inventory; TFT=Thin Film Transmitter; CRT=Cathode Ray Tube; DED=Dry Eye Disease; HT=Hypertension; BMI=Body Mass Index; GHQ12=General Health Questionnaire

VDT Use and Psychosocial Effects

Tomei et al. (2006) examined the effects of VDT associated work on stress levels. Their study clustered components of stress into five dimensions: (i) Depression; (ii) anxiety; (iii) lack of social support; (iv) somatization, and (v) aggressiveness. The researchers found stress levels to be significantly higher in VDT operators. Women experienced higher levels of anxiety and aggressiveness; whereas men experienced somatization and aggressiveness. Although not statistically significant ($p>0.05$), depression in women VDT workers were elevated in comparison to their male counterparts.

Ye et al. (2007b) found a borderline association between duration of VDT use (≥ 5 hours versus ≤ 5 hours) and high 12 item General Health Questionnaire scores (GHQ-12) which suggests that there is a deterioration of mental health with longer VDT usage. The investigators suggested that rest and breaks during VDT use can improve states of mental health. Female VDT users who were less than 40 years of age reported higher GHQ-12 scores. In addition, they suggested that physical symptoms such as eyestrain, musculoskeletal symptoms, may result in poor mental health.

Similar findings were reported by Nakazawa et al. (2002) who suggested that duration of exposure to VDTs of more than 5 hours/ day may be associated with deterioration in mental health as well as sleep related symptoms. Conversely, Hsu and Wang (2003) suggested that psychosocial factors such as increased job load, monotonous work and lack of control over the job can have effects over physical symptomatology including musculoskeletal discomforts in the upper extremities and back. Specifically, they found an association between back discomfort and monotonous work among VDT workers. Similarly Klussmann et al. (2008) found a statistically significant association between a lack of job satisfaction and neck and hand/wrist symptomatology

Balci and Aghazadeh (2003) found that the type of task performed can influence psychosocial states of mind. For example, they reported that mental arithmetic tasks can result in poorer performance and a higher psychological discomfort than simple data entry tasks. Similarly, Dainoff, Cohen and Dainoff (2005) also found that ergonomic intervention can have a positive effect on psychosocial states.

Yoshioka, Siajo, Kita, Sato, Kwaharada, Fukui and Kishi (2012) examined sex differences; insomnia, and their relationship to paid work and family responsibilities. Type of occupations (e.g. shift work; VDT work); marital status, and caregiving of children and dependents were all found to be independently associated with insomnia. However, when work and family characteristics were adjusted for statistically, the risk of paid work and family responsibilities affecting sleep duration and sleep patterns were comparable between males and females. In addition, Yoshioka and coworkers (2008) examined an association between duration of VDT work and lack of sleep or insomnia. They found that those who spend more than 6 hours per day on VDTs were more likely to suffer from insomnia than those who spend less amount of VDT time. Furthermore, those who work with VDTs more than 6 hours per day had problems with total sleep duration and experience sleepiness during the day, in comparison to those who spent less than 2 hours per day in front of VDTs. Furthermore, those who spent between 4-6 hours per day on VDTs had problems with sleep induction and awoke earlier than desired.

Kubo, and coworkers (2006) examined a relationship between VDT use and Sick Building Syndrome (SBS). They found that although there is a positive relationship between hours of VDT use and SBS in men, the prevalence was highest with the longest hours of VDT use in women. However, among women, the symptoms of Sick Building Syndrome (such as headache, respiratory symptoms such as dry cough and cold, tiredness and eye symptoms) disappeared when adjustments for psychosocial factors were made. These psychological factors included interest in work, work overload, control over work, colleague support and disturbed human relations. The symptoms of SBS remained significant among men despite adjustments for psychological factors. This suggests a role of psychosocial factors in mediating the effects of VDT work. However, this sex difference, was not addressed in this study.

Thomée, Härenstam and Hagberg (2011) examined the association between psychosocial aspects (i.e. availability demands; perceived stress on accessibility, and being awakened at night by the mobile phone) and mental health symptoms (i.e. depression; stress, and sleep disturbances) associated with mobile phone use. They noted that, in a cross-sectional analysis, frequency of mobile phone use, round the clock accessibility and being awakened at night by the mobile phone was associated with stress, sleep disturbances and depression in young adults. In contrast, prospectively, they found frequency of mobile phone use to be a risk factor for sleep disturbances in men and a risk factor for depression in both men and women. There was no prospective association between the accessibility to mobile phones and stress, and between being awakened by a mobile phone at night and mental health outcomes (i.e. sleep disturbances, depression and stress). Table 2.5 summarizes for the reader the effects of exposure to VDTs and psychosocial findings. These studies identify a negative effect on psychosocial parameters in individuals exposed to VDTs. Taken together, these studies suggest that there is a negative effect of VDTs on psychosocial factors of those exposed to VDTs of more than 5 hours daily.

Table 2.5 VDT exposure and Psychosocial Effects

Author(s), year, country	**Research design/methods**	**Ranking**	**Major findings**
Balci & Aghazadeh (2003), USA	Randomized experimental design N= 10, males; College Students, Right-handed, Humming-Sligo procedure was followed in the analysis=Perform a multiple analysis of variance (MANOVA) and separate analysis of variance (ANOVA) tests were applied for each variable. Wilk's lambda was selected as the MANOVA test criterion	II	15/micro schedule was found to have the lowest discomfort in the neck, lower back and chest and highest performance, compared with 30/5 and 15/ micro schedules. Data entry task usually resulted in lowest upper extremity discomfort compared with mental arithmetic task. 30/5 work-rest schedule had lowest eye-strain and blurred vision along with the 15/ micro schedule. Mental arithmetic task resulted in the lowest eye-strain compared to Data Entry task. Data entry task participants performed faster, more accurately and had higher performance than those in the mental arithmetic. 15/ micro also resulted in higher speed, accuracy and performance compared to the other two schedules

Author(s), year, country	Research design/methods	Ranking	Major findings
Dainoff, Cohen & Dainoff (2005) USA	Quasi-experimental study design, N=26, female employees of Cincinnati Service Center of the US Internal Revenue Service, age= 41.02 (SD=9.58), data entry clerks, mean number of years at work=15.71 (SD=6.55); 9 females married with children; 5 married with no children, 10 not living with another adult (8 of them had children). ; Tools=questionnaires, ergonomic redesign, follow up	II	Study found marked decrease in trigger points from commencement to 30 Day post-test overall *F* test, *Fr* =198.69,($p < .001$ for 26 subjects and 3 conditions); marked decrease in shoulder stiffness, increase in shoulder range of motion and decrease in pain following intervention (chi square (2 *df*)= 817.5, $p < .001$). Marked decrease in neck pain following intervention (chi square (2 *df*) = 429.4, $p < .001$). Decrease of intensity and frequency of pain/discomfort of neck, shoulder

Author(s), year, country	**Research design/methods**	**Ranking**	**Major findings**
Hsu & Wang (2003), Taiwan	Cross-sectional study design, N= 119, data-entry personnel=10, Programming engineers=40, CAD engineers=18, fabrication engineers=51, Tools= Questionnaire, Job Stress Scale (JSTS), Job Satisfaction scale (JSAS), multivariate logistical regression techniques	IV	Overall prevalence of upper extremity discomfort including neck, shoulder, upper arm, forearm/elbow, wrist and fingers was 42%. Full-time VDT users have higher prevalence rates of upper extremity discomforts than do part-time VDT users. This study could not confirm the association between length of VDT working time and increase in discomfort. This study reported increase in visual strain with shorter viewing distance; deviation of monitor height from the participants preferred position caused greater neck/shoulder discomfort. There was significant correlation between monotonous work and back discomfort among VDT users. This study also suggested that psychosocial factors are more predictive than physical and ergonomic factors for lower extremity discomforts in logistic regression models.
Klussmann, et al. (2008), Germany	Cross-Sectional Study design; N=81, mean age (39.9 +/- 9.5 years) Tools= BiFra (German VDTquestionnaire), Questionnaire (Nordic Questionnaire), Psychosocial questionnaire (COSPOQ), physical examination, SPSS, logical regression analysis	IV	Neck and Shoulder complaints (55% and 38%, respectively) more than upper arm complaints and hand/wrist, and elbow/ forearm complaints (21% and 15% respectively). Women had complaints more than men of neck and shoulder musculoskeletal symptoms. Low, but significant relationship between job

Author(s), year, country	Research design/Methods	Ranking	Major Findings
			satisfaction and neck and hand/wrist symptoms observed. Typing more than 6 hrs/day at a VDT station had a significant impact on the prevalence of neck symptoms. Predictors include >20 years on the job, high lack of job satisfaction, typing > 6 hrs/ day and limitations to take breaks significantly increased the 12-month prevalence of one or more musculoskeletal symptoms
Kubo, et al. (2006), Japan	Cross-sectional study design; N=1,881; Tools=Questionnaire-Miljomedicin 040; Multivariate logistic regression	IV	The relation between SBS and hours of VDT use was 2 times higher in women when compared to men (7.9% vs. 3.9%, respectively). This prevalence increased with increase in hours of VDT use, however, in women, this association disappeared with adjustment of psychosocial factors.
Nakazawa, et al. (2002), Japan	Survey design, N= >25000; age 20-59, clerical workers, Tools=ANOVA	IV	Seventeen subjective symptoms divided into 3: Factor 1 (mental symptoms, Factor 2 (physical symptoms) and Factor 3 (Sleep-related symptoms), Cronbach's alpha was 0.7 for mental symptoms, 0.5 for both physical & Sleep related symptoms, suggesting a relationship between duration of daily

Author(s), year, country	**Research design/methods**	**Ranking**	**Major Findings**
			VDT use and physical symptoms, mental and sleep symptoms score was significantly higher for groups using VDTs>5 hrs/day
Thomée, Härenstam & Hagberg (2011), Sweden	Cross-sectional study design; N=4156; males=1455, females=2701, ages 20-24 yrs. Tools=Questionnaire; Spearman correlation, Cox proportional hazard model, robust variance option (COVS)	IV	There is a positive correlation between mobile phone use and being awakened at night for both men and women ($p<0.001$); availability demands ($p<0.001$) for both men and women. A positive correlation between mobile phone use and accessibility stress was slightly less for men ($p<0.01$) then for women ($p<0.001$). Mobile phone overuse was significant for both men and women ($p<0.001$). There was a positive correlation between being awakened at night and availability demands equally for both men and women ($p<0.001$). However men suffered less stress ($p<0.05$) when compared to women ($p<0.001$) when association between being awakened at night and stress was correlated. There was no association between availability demands and stress for both men and women.

Author(s), year, country	**Research design/methods**	**Ranking**	**Major findings**
Tomei, et al., (2006) Italy	Survey design; N=60 (30 VDT workers; 15 males and 15 females; 30 Non VDT workers; 15 males and 15 females); Tools=Questionnaire (Rapid Stress Assessment Scale)	IV	Stress level was higher in VDT operators compared to control group. The result was significant for anxiety and aggressive clusters in women ($p<0.001$ and $p<0.05$) and for somatization and aggressive clusters in men ($p<0.05$ and $p<0.05$). In woman there is a considerable amount of depressive symptomatology but does not approach the level of significance required for the statistical consideration
Ye, et al. (2007b), Japan	Cross-sectional study design, N=2,327, mean age=39.5 years, Tools=GHQ-12 Questionnaire (Japanese version); Logistic regression analysis	IV	Borderline association between duration of daily VDT use and high GHQ-12 scores suggested that longer VDT use resulted in deterioration of mental health status. Rests and breaks during VDT work were found to be a protective factor in the multiple regression model (OR=0.67, 95% CI, 0.52-0.86). VDT users younger than 40 years of age reported more higher GHQ-12 scores. Physical symptoms such as musculoskeletal pain were found to be related to poor mental health status

Author(s), year, country	**Research design/methods**	**Ranking**	**Major findings**
Yoshioka, (2012), Japan	Cross-Sectional study design;N=8416 employees, 6659 men, 1757 women; ages 34-59 years, Tools= Questionnaire-Athens Insomnia Scale (AIS). Occupational stress measured by Demand Control model and effort-reward imbalance model	IV	Prevalence of insomnia among Japanese local government employees was 21.2% (males) and 31.4% (females). In the telecommunications company one-month point prevalence was 32.6%-43.9% (males) and 41.8%-44.6% (females). But when adjusted for work and family characteristics this difference was attenuated and no longer significant
Yoshioka, et al., (2008). Japan	Cross-sectional study design; N=8,416; men=6,659 & women= 1,757, age=34-59 years. Tools=Questionnaire, Athens Insomnia Scale (AIS) & Student's t test, Chi-Squared test, stepwise regression analysis	IV	Those who spent >6 hours/day or longer on VDT work more likely to suffer from insomnia, especially in two aspects, total sleep duration (p=0.001) and sleepiness during the day (p=0.010). Those who worked on VDTs 4-6hrs/day had problems with sleep induction and awoke earlier than desired.

Legend: N=11; ANOVA=Analysis of Variance; MANOVA=Multiple Analysis of Variance; VDT=Video Display Terminals; JSTS=Job Stress Scale; JSAS=Job Satisfaction scale; COSPOQ=Psychosocial questionnaire; AIS=Athens Insomnia Scale; SBS=Sick Building Syndrome

<u>Cell Phone Use and Depressive Symptoms</u>

Sánchez-Martínez and Otero (2009) examined the intensity of cellular phone use among adolescents and the negative health effects that maybe associated with it. They noted that over 96.5% of adolescents aged between 13-20 years of age had their own cellular phones and over 15.9% of those had two or more devices. Females were slightly higher in terms of cellular phone possession (98.2%), when compared to males (94.8%). They found that approximately 76.3% sent text messages with their cellular phones and among them 18.2% sent more than four text messages per day. They also found that over 41.7% used their cellular phones intensively. Their study suggested that adolescents who suffered from depressive symptomatology were more likely to use their cellular phones intensively. In addition, they found that intensive use of cellular phones was closely associated with cellular phone dependence, and approximately 20% of those surveyed were cellular phone dependent.

Yilrdim (2014) examined the extent of nomophobia among university students. Although, the study's main objective was to develop a reliable questionnaire for nomophobia, four themes emerged from the participants. They were (i) not being able to communicate-participants relied heavily on their smartphones an its features for communication; (ii) losing connectedness-participants felt that without cellphones/smartphones they will lose the connectivity smartphones provide and be disconnected with their online identity; (iii) inability to access information-participants felt that they feel discomfort when not being able to access information on the smartphone instantly, and (iv) giving up convenience-participants felt constricted when giving up the luxury and convenience that the smartphone provides. Table 2.6 provides the reader with a summary of studies that examined exposure to cellular phones and their effect on moods in young adults. These studies suggests a negative association between the number of hours on the cellular phone and depression.

Table 2.6 Cellular Phone Use and Depressive Symptomatology

Author(s), year, country	**Research design/methods**	**Ranking**	**Major findings**
Sánchez-Martínez & Otero (2009), Spain	Cross-Sectional Study design, N=1,328 students (46.3% males, 53.7% females), age= 13-20 years (mean 15.7 years); Tools= Questionnaire, Pearson's Chi-Squared test, Binary logistic regression and Multivariate analysis	IV	96% of the study population had their own cell phones- proportion of females with cell phones was a bit higher (98.2%) when compared to males (94.8%) ($p<0.001$). About 76.3% of adolescents with cell phones send text messages and of that 18.2% send > 4 text messages/ day. 20% of those who were surveyed were dependent on their cell phones and among those females were more dependent (26.1%) than males (13%) ($p=0.000$)
Yildrim, C. (2014), USA	Mixed methods study design, N=301 (135 males, 166 females). Mean age= 20 years; Tools= Qualtrics, MPIQ= Mobile Phone Involvement Questionnaire, SPSS, Exploratory Factor Analysis, Cronbach's Alpha and Pearson's Correlation	IV/VI	Four themes emerge - (i) not being able to communicate; (ii) losing connectedness; (iii) not being able to access information (iv) giving up convenience

N=2; MPIQ=Mobile Phone Involvement Questionnaire

Internet Use and Psychosocial Effects

Morahan-Martin and Schumacher (2003) studied the association between loneliness and Internet use. They noted that lonely people used the Internet more often than people who consider themselves socially active. They enjoy the anonymity that the Internet can provide and therefore felt more at ease at making new friends. They also found that lonely people used the Internet to modulate their moods, in other words, they more often than not go online when they felt isolated, depressed or anxious. In addition, they found that those who use the Internet excessively are more likely to experience interference with social activities, occupation and suffer increased guilt. This study reports a negative association between prolonged Internet use and psychosocial state of the users suggesting that there is an increased probability of altered psychosocial state of upon prolonged exposure to the Internet.

Clark, Frith and Demi (2004) examined the relationship between Internet use and the physical, behavioural and psychosocial consequences. The researchers reported that some physical consequences are observed in the form of eyestrain, headaches, neck, back and wrist pain among Internet users. Females were reported to be more at risk for repetitive strain injuries. Additionally, participants who were high-end users of the Internet reported significantly lower scores on the behavioural subscale, indicating increased dependence on the Internet. In contrast to the above study, positive psychosocial consequences of Internet use were reported with moderate use of the Internet (6-14 hours/week). For example, increased ability to learn new skills and better connections with family and friends.

Kormas et al. (2011) examined the effect of Internet use among adolescents. The researchers termed Problematic Internet Use (PIU) as an individual’s inability to control his/her use of the internet, resulting in marked distress and/or inability to function. They found that the prevalence of PIU among adolescents was 1.5%. Approximately 19.4% of adolescents were found to be showing signs of potential PIU. The majority of participants found with potential PIU or PIU were male. The researchers noted that adolescents with PIU were lonelier and tended to have aggressive behaviours. However, those with PIU or potential PIU were not found to be lacking peer relations or social skills. Additionally, the researchers found that adolescents with PIU or potential PIU were two to eight times more likely to report global emotional or psychosocial maladjustments and thus may use the Internet to cope with their issues.

A similar study by Dixit et al. (2010) examined the prevalence of nomophobia among Indian medical students. They found that approximately 18.5% of the students reported to be nomophobic, irrespective of sex, according to the nomophobia questionnaire designed by Raines. Table 2.7 shows the effects of Internet use on psychosocial state of the user. Taken together these studies suggest a negative effect of prolonged VDT use among young adults.

Table 2.7 Exposure to Internet and Psychosocial Effects

Author(s), year and country	**Research design/methods**	**Ranking**	**Major Findings**
Morahan-Martin & Schumacher (2003), USA	Survey design, N=277, males=150, females=127, mean age=20.72 years. Tools=UCLA Loneliness scale, Scale of Internet behaviours, MANOVA, univariate ANOVA	IV	The study found that lonely users used the Internet more often than non-lonely users (p=0.012) and increased use of e-mail was statistically significant among lonely users when compared to non-lonely users (p=0.024). Lonely users used the Internet to relax (p=0.001), to meet people (p=0.056), for work (p=0.008), for emotional support (p=0.002), talking to others who have common interests (p=0.01) and to waste time (p=0.002). Lonely users were more likely to use Internet to communicate online rather than face-face communication, to modulate their moods and be negatively impacted by their Internet use(p=0.01)

Author(s), year, country	**Research design/methods**	**Ranking**	**Major findings**
Clark, D., Frith, K., Demi, A. (2004) USA	Correlational study design; N=293, predominantly Caucasian (86%), single (87.7%) and female (80%); mean age 21.2 years. Tools=ICONS questionnaire (Internet Consequences Scale); Pearson's Correlation, Multiple regression	IV	Participants sometimes experienced headaches, eyestrain, neck, back and wrist pain. Females reported more physical symptoms related to Internet use, when compared to when compared to men. Females appeared to be more at risk of repetitive strain injuries. Increased number of hours spent in front of computer was reported to be associated with lower scores on the behavioural scale (increased dependence). Positive psychosocial effects were found with moderate use (6-14 hours/week) of the Internet (better ability to learn new skills and feeling better connected to family and friends
Kormas et al. (2011), Greece	Cross-sectional study design, N=866, junior high and high school students, mean age = 14.7 years. Tools = SAS v. 9.0, Young Internet Addiction Test, Strength and Difficulties questionnaire, Student's t test, Chi-squared test, Fischer's Exact test, Stepwise multinomial logistic regression,	IV	PIU was reported in 1.5% of adolescents; potential PIU = 19.4%. Majority of those with PIU or potential PIU were male. Adolescents with PIU were found to be lonely and had aggressive behavioural tendencies. Adolescents with PIU or potential PIU were also found to have global emotional and psychosocial maladjustments which the participants tried to mitigate by going to the Internet for support

Author(s), year, country	Research design/methods	Ranking	Major findings
Dixit et al. (2010), India	Cross-sectional survey design, N=200; 106 males and 94 females, age= 17-28 years; Tools = Raines Nomophobia Quesionnaire; Frequency and percentage calculation	VI	Approximately 18.5% reported to be nomophobic irrespective of sex.

N=4; ANOVA=Analysis of Variance; MANOVA=Multiple Analysis of Variance; ICONS=Internet Consequences Scale; PIU=Problematic Internet use

Taken together this systematic review of the literature suggests that there is currently a dearth of investigations that have examined the relationship between electronic or digitally-based mobile devices and technologies with VDTs (e.g., cellular phones, tablets, iPods, laptop computers) (Table 2) and associated health effects in young adult Canadians. Furthermore, the literature review suggests a distinction between high-end and low-end users and implies that high-end users suffer most of the negative health consequences. High-end users are those who use VDTs for >5 hours/day and low end users are those who use VDTs for <5 hours/day.

The majority of studies reviewed concentrated on work (occupational)-setting and environments. Moreover, the potential health effects of these digitally-based mobile devices and technologies with VDTs on millennials who attend college or university has not been assessed to our knowledge to date. Hence, this study seeks to fill these gaps in the empirical literature by focusing on Canadian students who are high users of technology. Specifically, this thesis assesses the relationships between self-reported signs and symptoms manifested due to exposure to a variety of mobile electronic and digital devices with VDTs. This proposal is important because there is a dearth of investigations which have examined the negative health effects of VDTs in young adults especially within a Canadian context. Therefore the aim of the proposal is to examine the relationship between exposure to mobile electronic or digital devices and technologies with a video display terminal (VDTs) (e.g., laptops, cell phones, tablets, iPods) and the potential negative health effects associated with the use of these devices among university students in Oshawa, Ontario.

Research Question:

1. Do increases in VDT exposure times result in negative maladaptive physical responses such as pain or discomfort as well as changes in self-reported perceptions of one's state of mental and social well-being such as stress, anxiety, lack of sleep, loneliness in young Canadian adults in the Oshawa, Ontario?
2. Is there a difference between the sexes with regard to pain, discomfort, anxiety, stress, lack of sleep and loneliness in young Canadian adults in Oshawa, Ontario when exposed to VDTs?

PRIMARY HYPOTHESIS

Both male and female UOIT student users of VDTs will complain of negative health effects.

SECONDARY HYPOTHESES

1. Female students who use VDTs will complain of increased physical pain and discomfort (e.g., neck, shoulder, back), in comparison male students.
2. Female students who use VDTs will complain of increased mental stress and anxiety, in comparison to male students.

3. Female students who use VDTs will complain of increased eye discomfort (e.g. eyestrain, blurred vision/double vision, redness of eyes) in comparison to male students.
4. Female students who use VDTs will report increased levels of addiction to technology, in comparison to male students.
5. Female students who use VDTs will complain of increased headaches and migraines in comparison to male students.

Summary and Conclusions

This systematic review of the literature suggests that there are negative effects on the health of young adults with prolonged exposure times to mobile devices and other technologies with VDTs. The majority of studies reveal an emerging concern of negative health outcomes with widespread use of VDTs. Little is known about the effects of VDTs on the health of young adults especially from the Canadian perspective/ experience. Accordingly, this study seeks to fill these gaps in the empirical literature by focusing on male and female University of Ontario Institute of Technology (UOIT) students as high users of technology, and by assessing the relationship with respect to self-reported signs and symptoms manifested due to exposure to a variety of mobile electronic and digital devices with VDTs.

Chapter 3

Research Design and Methodology

Study Design and Methods

An observational study employing a self-reported demographic and health questionnaire was employed to elicit information related to exposure to a variety of mobile electronic and digitally-based technologies and devices that are equipped with VDTs (e.g., cellular phones, laptops), and various health related conditions and disorders (e.g., neck and shoulder pain, carpal, stress and anxiety, sleep disturbances). Limitations of this type of approach include possible high rates of refusals and observer bias. I have chosen this type of study because I plan to capture a wide variety of behaviours, events and associated health conditions (Polit & Beck, 2004).

Recruitment of Participants

A non-random, purposive, convenience sampling method was employed to target various undergraduate students at UOIT. The recruitment of these students was done through oral invites/addresses made in select classes at the North Campus of UOIT

Sampling is a method in which a researcher selects a representative proportion of individuals from the target population (Polit and Beck, 2004; Procter & Allan, 2006). Sampling raises the efficiency of the study (Haber, 2006). I acknowledge that a possible limitation with non-probability sampling is that it may not represent the entire population, which increases the chance for underrepresentation (Polit and Beck, 2004). However, this study employed a non-random, purposive, convenience type of sampling method because it is relatively low cost in nature, targets a specific population (i.e. university undergraduate students), and can help to determine the effects of key variables or characteristics for the target population (Haber, 2006; Polit & Beck, 2004).

Hence, it was assumed that the subjects were knowledgeable users of technology and would be able to provide insights into their uses, exposure times, and associated health conditions experienced (Procter & Allan, 2006; Speziale, 2006). Instances where a purposive sample can be employed include; (i) Collecting data within a highly specific population, and (ii) collecting descriptive data (Haber, 2006). A possible limitation is that it may create selection bias (Polit & Beck, 2004), and therefore the sample may not be truly representative in nature (Procter & Allan, 2006).

Health Related Questionnaire

The questionnaire that was used in this study consisted of 4 components-(i) A self-reported demographic and VDT questionnaire, here named the "Technology Use and Health Questionnaire" (TUHQ); (ii) the Nordic Musculoskeletal Questionnaire (NMQ), which is a validated questionnaire from the review of literature that was adapted with respect to the hypotheses presented in this study related to neck/shoulder pain and eyestrain; (iii) the Short Form Health Survey-12 (SF-12) was used to elicit symptoms of psychosocial aspects of VDT usage; and (iv) the Internet Addiction Questionnaire (IAT) which was adapted to reflect health effects relate to VDT exposure.

Reliability is the extent to which a questionnaire will produce a similar result if re-administered to the same group if the conditions remain unchanged (Black, 2006). Validity refers to whether or not a specific questionnaire measures what it is intended to measure and assess specific constructs (Black, 2006; Burns and Grove, 2011a). The reliability of the NMQ has been reported to be fair to good with (Kappa [*k*] coefficient values ranging from 0.40-0.75. The questionnaire is repeatable as majority of *k* values for the symptom variables were above 0.55 (Cook, Rosecrance, Ketchen, Merlino & Anton, 2002). Disagreement with the questionnaire when compared to the clinical history was in the range of 0-20% (therefore showing a validity of 80%-100%) (Kuorinka et al, 1987; Crawford, 2007). The reliability of the SF-12 for the Physical Component Summary (PCS) and the Mental Component Summary (MCS) was 89% and 76%, respectively. The Relative Validity (RV) of the SF-12 with respect to the PCS ranged between 0.43-0.93; RV for the MCS was found to be 0.60-1.07 in comparison to the SF-36 (Ware, Kosinksi, & Keller, 1996). The Internet Addiction Test (IAT) was found to have a reliability ranging between 54%-82% (Widyanto & McMurran, 2004)

The TUHQ consisted of 7 Visual Analogue Scales (VAS) type questions which was used to assess the 5 specific hypotheses. VAS are helpful to measure strength, magnitude or intensity of the participants' subjective feelings, sensations or attitudes about specific signs and symptoms, and situations (Burns & Grove, 2011a). Moreover, VAS's can be employed to assess experiences such as pain, dizziness, and eyestrain among other variables. The questionnaire was administered and distributed in class via hardcopies by the graduate student.

Questionnaires are commonly employed for survey types of research designs (Black, 2006). The questionnaire consisted of a combination of closed-ended (when there is a fixed response to a question) and open-ended (when a researcher wants an answer in the subjects own words) questions (Whittemore & Grey, 2006). A Likert-type scale was also employed. A Likert-type scale consists of a list of statements from which a subject has to choose, which reflects the degree to which the respondent agrees or disagrees with an opinion or statement that is written (e.g., Strongly Agree, Agree, Neither, Disagree, Strongly Disagree) (Polit & Beck, 2004). The choice of question formats used in this study reflects the capability of the questionnaire to achieve the maximum range of responses and opinions, to quantify use of mobile electronic and digital devices (e.g. cellular phones, laptops), and to determine total exposure times to each.

Data Analysis

For this study, a database using SPSSX ™ version 21 (Chicago, IL) and Microsoft Excel 2011 was created for the analysis of both descriptive and inferential statistics. Specifically, data using descriptive statistics (e.g. mean, standard deviation, ranges) are presented in tabular or graphic forms. Inferential statistical procedures included Independent samples *t* test, Chi-Squared test, Pearson's Correlation, simple linear regression and path analysis. The key dependent variables were eyestrain, headaches, neck pain, shoulder pain, muscular pain, pain in the fingers, fatigue, restlessness, anxiousness. The key independent variables were age, sex, amount of time spent on the cell phone/computer/social networking sites/Twitter/YouTube/coursework, number of cellphones carried, and the number of electronic devices carried, number of charges for the electronic devices carried. A p-value of ≤ 0.05 was deemed significant *a priori* for all statistical procedures conducted.

The mean, standard deviation and ranges are all measures of central tendency. The mean is a commonly used measure of central tendency and many statistical tests are based upon it. Standard deviation is commonly used to analyze interval or ratio-level data and provides a standard of variability. Ranges are simply the result of subtracting the highest value with the lowest and provides a gross descriptive measure (Polit & Beck, 2004). These measures of central tendency were calculated to obtain descriptive statistics on the key variables such as age, sex, amount of time spent on the cell phone/computer/social networking sites/Twitter/YouTube/coursework, number of cellphones carried, number of electronic devices carried, number of charges for the electronic devices carried (independent variables) and dependent variables such as physical health, mental health, pain (neck/shoulders and wrists), mental stress/anxiety, eye discomfort, headaches/migraines and technological dependence.

Independent samples *t*-test were employed and are helpful in testing whether any difference exists between two means (Polit & Beck, 2004). It has been shown that *t*-test is a robust test when sample size is large and has been found to yield accurate results even with departures from normality (Polit, 2010).

The Chi-Squared test was used for nominal data such as proportion of males and females with reported problems in the neck; problems in the shoulders; problems in the upper back; problems in the wrists/ hands; problems in lower back; interference with school work; exhaustion; loss of social activities; staying online longer than intended; schoolwork suffering as a result of staying online; lack of sleep; going out with others are examined (Munro, 2005). The Pearson's Chi-Square tests the existence of a relationship between two nominal variables (categorical variables) being cross-tabulated in a contingency table (Polit, 2010).

Pearson's correlation was also used to describe the relationship between key variables such as age and time spent on Facebook™ (Polit & Beck, 2004).

Multiple linear regression and path analysis were employed to determine the relationship between variables such as physical pain and discomfort, mental stress and anxiety, eye discomfort, headaches and migraines as well as addiction to technology. Simple regression was used to make predictions on key dependent variable. Path analysis also uses regression but it is useful to study patterns of causation (Polit & Beck, 1991).

Advantages of a cross-sectional study include: i) it is cost effective; ii) takes little time, and 3) it is easy to administer. The disadvantages are i) it is just a snapshot; ii) causation cannot be established, and iii) cannot examine trends/patterns over time.

Chapter 4

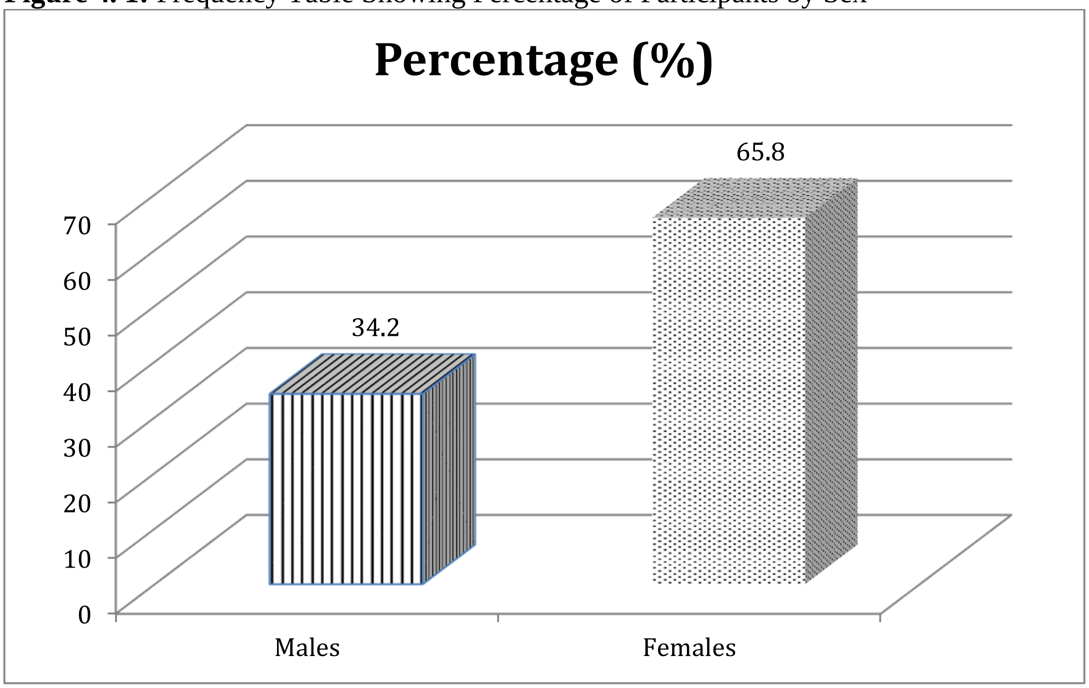
Results

Results

Demographic findings

This chapter provides the reader with a summary of the major results obtained. The results are presented in tabular or graphical form. Descriptive statistics presented include mean, standard deviation (S.D.) and frequencies. The inferential statistics reported include independent student t-test, Pearson's correlations, multiple regressions and path analysis. A total sample size of 278 university students in Oshawa, Ontario participated in the study, of which 65.83% were females (aged between 17-50 years) and 34.17% were males (aged between 18-64 years) (see Figure 4.1 below).

Figure 4. 1: Frequency Table Showing Percentage of Participants by Sex



Note: Total number of males = 95, and total number of females = 183

<u>Exposure times</u>

This section provides an overview of the findings with respect to specific exposure times for various Video Display Terminal (VDT) devices and users.

Table 4.1: Sex-specific Exposure Times

Variable	Male	Female	p-values
Facebook time (in minutes)	75.16±77.40	88.69±84.67	0.19
Twitter time (in minutes)	27.79±74.04	22.62±56.43	0.52
Time reading e-mails (in minutes)	37.58±74.52	40.16±30.73	0.68
Time playing games (in minutes)	63.16±101.73	13.44±36.08	**
Time on YouTube (in minutes)	75.02±99.12	62.97±71.92	0.25
Time on Internet (in minutes)	145.21±174.83	121.82±111.45	0.24
Time on Coursework (in minutes)	159.89±147.46	231.34±137.64	**
Talking on cell (in minutes)	31.60±41.59	41.21±48.37	*
Texting (in minutes)	103.89±153.83	186.72±228.73	**
Browsing Internet on cell phone (in minutes)	35.05±44.40	43.52±58.79	0.22
Hours spent on technology (in minutes)	750.02±571.60	846.57±445.27	0.12

Note: All values shown are shown are $\overline{X}$ ±S.D. ** indicates $p \leq 0.01$, * indicates p=0.10 Although some of the significant results had large SDs when calculating using SPSS software, they were confirmed to be accurate via Excel software also.

Table 4. 1 (above) shows the mean exposure times to VDTs via participation in various online activities (e.g. Facebook, Twitter). The p-values in the tabular columns were estimated by conducting Student *t*-tests. The standard deviation is the most widely sued measure of variability; like the mean the SD considers every score in a distribution (Loiselle

& Profetto-McGrathHungler, 2011). A t-test is a parametric statistical test used to analyze the difference between two means (. On an average, males reported spending significantly more time playing games on the Internet (63.16±101.73), when compared to females (13.44±36.08, p value < 0.01). Females spent more time on coursework (231.34±137.64), when compared to their male counterparts (159.89±147.46, p value < 0.01). Additionally, females reported spending significantly more time texting on their cell phones (186.72±228.73), when compared to males (103.89±153.83) (p value < 0.01). Although not significant, females reported spending more time on technology (846.57±445.27), when compared to males (750.02±571.60, p = 0.12) overall.

The following tables below provide the reader with a comparative overview of the findings related to the type of activity associated with exposure to various VDTs. Table 4.2. (below) suggests a strong significant correlation between the total number of hours spent in front of VDTs for both male and female students and the time spent Internet browsing (r=.73, p ≤ 0.01). There was a moderate but significant correlation between the total number of hours spent in front of VDTs and texting on the cell phone (r=. 59, p ≤ 0.01), coursework (r=.53, p ≤ 0.01), watching YouTube ™ videos (r=. 49, p ≤ 0.01) and browsing the Internet on cell phones (r=.50, p≤0.01). There was a weak correlation between total number of hours spent by both males and females in front of VDTs and playing games online (r=.20, p ≤ 0.01).

Table 4.2: Pearson's Correlation showing relationship between total number of hours exposed to VDT and type of VDT activity (combined)

Correlations

		Time spent on Facebook in minutes	Time spent on Twitter in minutes	Time spent reading emails in minutes	Time spent playing games on the internet in minutes	Time spent on YouTube in minutes	Time spent on Internet browsing in minutes	Time spent on Coursework in minutes	Time spent talking on cell phone in minutes	Time spent texting on cell phone in minutes	Time spent browsing internet on cell phone in minutes	I would rate my dependence on technology as	Total number of hours spent on technology
Time spent on Facebook in minutes	Pearson Correlation	1	.273**	.298**	.067	.131*	.507**	.273**	.135*	.221**	.446**	.152*	.629**
	Sig. (2-tailed)		.000	.000	.263	.029	.000	.000	.025	.000	.000	.011	.000
	N	278	278	278	278	276	275	274	276	278	277	277	278
Time spent on Twitter in minutes	Pearson Correlation	.273**	1	.466**	-.009	.094	.309**	.087	.123*	.157**	.122*	.013	.421**
	Sig. (2-tailed)	.000		.000	.881	.120	.000	.150	.041	.009	.042	.835	.000
	N	278	278	278	278	276	275	274	276	278	277	277	278
Time spent reading emails in minutes	Pearson Correlation	.298**	.466**	1	.021	.081	.355**	.236**	.249**	.054	.078	-.127*	.446**
	Sig. (2-tailed)	.000	.000		.727	.182	.000	.000	.000	.369	.195	.035	.000
	N	278	278	278	278	276	275	274	276	278	277	277	278
Time spent playing games on the internet in minutes	Pearson Correlation	.067	-.009	.021	1	.118	.216**	-.128*	.057	-.044	.063	-.115	.195**
	Sig. (2-tailed)	.263	.881	.727		.050	.000	.034	.349	.468	.296	.056	.001
	N	278	278	278	278	276	275	274	276	278	277	277	278
Time spent on YouTube in minutes	Pearson Correlation	.131*	.094	.081	.118	1	.499**	.161**	.025	.130*	.148*	.113	.486**
	Sig. (2-tailed)	.029	.120	.182	.050		.000	.008	.679	.031	.014	.060	.000
	N	276	276	276	276	276	275	273	275	276	275	275	276
Time spent on Internet browsing in minutes	Pearson Correlation	.507**	.309**	.355**	.216**	.499**	1	.241**	.173**	.116	.373**	.137*	.733**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.004	.055	.000	.023	.000
	N	275	275	275	275	275	275	273	274	275	274	274	275
Time spent on Coursework in minutes	Pearson Correlation	.273**	.087	.236**	-.128*	.161**	.241**	1	.093	.124*	.155*	.092	.528**
	Sig. (2-tailed)	.000	.150	.000	.034	.008	.000		.126	.040	.010	.131	.000
	N	274	274	274	274	273	273	274	273	274	274	273	274
Time spent talking on cell phone in minutes	Pearson Correlation	.135*	.123*	.249**	.057	.025	.173**	.093	1	.139*	.263**	-.108	.327**
	Sig. (2-tailed)	.025	.041	.000	.349	.679	.004	.126		.021	.000	.073	.000
	N	276	276	276	276	275	274	273	276	276	275	275	276
Time spent texting on cell phone in minutes	Pearson Correlation	.221**	.157**	.054	-.044	.130*	.116	.124*	.139*	1	.201**	.121*	.591**
	Sig. (2-tailed)	.000	.009	.369	.468	.031	.055	.040	.021		.001	.044	.000
	N	278	278	278	278	276	275	274	276	278	277	277	278
Time spent browsing internet on cell phone in minutes	Pearson Correlation	.446**	.122*	.078	.063	.148*	.373**	.155*	.263**	.201**	1	.018	.502**
	Sig. (2-tailed)	.000	.042	.195	.296	.014	.000	.010	.000	.001		.761	.000
	N	277	277	277	277	275	274	274	275	277	277	276	277
I would rate my dependence on technology as	Pearson Correlation	.152*	.013	-.127*	-.115	.113	.137*	.092	-.108	.121*	.018	1	.122*
	Sig. (2-tailed)	.011	.835	.035	.056	.060	.023	.131	.073	.044	.761		.043
	N	277	277	277	277	275	274	273	275	277	276	277	277
Total number of hours spent on technology	Pearson Correlation	.629**	.421**	.446**	.195**	.486**	.733**	.528**	.327**	.591**	.502**	.122*	1
	Sig. (2-tailed)	.000	.000	.000	.001	.000	.000	.000	.000	.000	.000	.043	
	N	278	278	278	278	276	275	274	276	278	277	277	278

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

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

Table 4.3 (below) shows a strong correlation between the male university students exposed to VDTs and Internet browsing ($r=.81$, $p \leq 0.01$). There was a moderate correlation between male university students with respect to total number of hours spent in front of a VDT and texting ($r=.55$, $p \leq 0.01$); browsing the Internet on their cell phones ($r=.54$, $p \leq 0.01$); watching YouTube ™ videos ($r=.50$, $p \leq 0.01$), and doing coursework online ($r=.41$, $p \leq 0.01$). Additionally, there was a weak but significant correlation between male university students' total number of hours spent in front of a VDT and playing games online ($r=.30$, $p \leq 0.01$).

Table 4.3: Pearson's Correlations showing relationship between total number of hours exposed to VDTs and type of VDT activity among male university students

Correlations[a]

		Time spent on Facebook in minutes	Time spent on Twitter in minutes	Time spent reading emails in minutes	Time spent playing games on the internet in minutes	Time spent on YouTube in minutes	Time spent on Internet browsing in minutes	Time spent on Coursework in minutes	Time spent talking on cell phone in minutes	Time spent texting on cell phone in minutes	Time spent browsing internet on cell phone in minutes	Total number of hours spent on technology
Time spent on Facebook in minutes	Pearson Correlation	1	.641**	.564**	.142	.185	.574**	.231*	.564**	.376**	.400**	.744**
	Sig. (2-tailed)		.000	.000	.169	.075	.000	.025	.000	.000	.000	.000
	N	95	95	95	95	94	94	94	94	95	95	95
Time spent on Twitter in minutes	Pearson Correlation	.641**	1	.784**	.010	.044	.530**	.189	.557**	.212*	.305**	.647**
	Sig. (2-tailed)	.000		.000	.925	.677	.000	.068	.000	.039	.003	.000
	N	95	95	95	95	94	94	94	94	95	95	95
Time spent reading emails in minutes	Pearson Correlation	.564**	.784**	1	-.008	.090	.501**	.331**	.490**	.110	.048	.629**
	Sig. (2-tailed)	.000	.000		.937	.389	.000	.001	.000	.288	.644	.000
	N	95	95	95	95	94	94	94	94	95	95	95
Time spent playing games on the internet in minutes	Pearson Correlation	.142	.010	-.008	1	.091	.175	-.085	.154	.099	.173	.300**
	Sig. (2-tailed)	.169	.925	.937		.384	.092	.413	.139	.338	.094	.003
	N	95	95	95	95	94	94	94	94	95	95	95
Time spent on YouTube in minutes	Pearson Correlation	.185	.044	.090	.091	1	.620**	.020	.130	.154	.286**	.499**
	Sig. (2-tailed)	.075	.677	.389	.384		.000	.847	.211	.137	.005	.000
	N	94	94	94	94	94	94	94	94	94	94	94
Time spent on Internet browsing in minutes	Pearson Correlation	.574**	.530**	.501**	.175	.620**	1	.151	.434**	.202	.394**	.810**
	Sig. (2-tailed)	.000	.000	.000	.092	.000		.146	.000	.050	.000	.000
	N	94	94	94	94	94	94	94	94	94	94	94
Time spent on Coursework in minutes	Pearson Correlation	.231*	.189	.331**	-.085	.020	.151	1	.165	.034	-.004	.411**
	Sig. (2-tailed)	.025	.068	.001	.413	.847	.146		.113	.742	.971	.000
	N	94	94	94	94	94	94	94	94	94	94	94
Time spent talking on cell phone in minutes	Pearson Correlation	.564**	.557**	.490**	.154	.130	.434**	.165	1	.448**	.568**	.674**
	Sig. (2-tailed)	.000	.000	.000	.139	.211	.000	.113		.000	.000	.000
	N	94	94	94	94	94	94	94	94	94	94	94
Time spent texting on cell phone in minutes	Pearson Correlation	.376**	.212*	.110	.099	.154	.202	.034	.448**	1	.422**	.545**
	Sig. (2-tailed)	.000	.039	.288	.338	.137	.050	.742	.000		.000	.000
	N	95	95	95	95	94	94	94	94	95	95	95
Time spent browsing internet on cell phone in minutes	Pearson Correlation	.400**	.305**	.048	.173	.286**	.394**	-.004	.568**	.422**	1	.538**
	Sig. (2-tailed)	.000	.003	.644	.094	.005	.000	.971	.000	.000		.000
	N	95	95	95	95	94	94	94	94	95	95	95
Total number of hours spent on technology	Pearson Correlation	.744**	.647**	.629**	.300**	.499**	.810**	.411**	.674**	.545**	.538**	1
	Sig. (2-tailed)	.000	.000	.000	.003	.000	.000	.000	.000	.000	.000	
	N	95	95	95	95	94	94	94	94	95	95	95

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

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

a. Sex, male and female = male

Table 4.4 (below) shows a strong correlation between the total number of hours spent in front of VDTs among female university students and Internet browsing ($r=.68$, $p \leq 0.01$); texting on the cell phone ($r=.64$, $p \leq 0.01$), and coursework done online ($r=.61$, $p \leq 0.01$). Additionally, there is a moderate correlation between the total number of hours spent in front of a VDT among female university students and watching YouTube ™ videos ($r=.49$, $p \leq 0.01$) and browsing on the Internet on their cell phones ($r=.50$, $p \leq 0.01$). Furthermore, there was a weak correlation between female university students' total number of hours exposed to VDTs and playing games online ($r=.18$, $p \leq 0.05$).

Table 4.4: Pearson's Correlation showing relationship between total number of hours exposed to VDTs and type of activity among female university students

Correlations[a]

		Time spent on Facebook in minutes	Time spent on Twitter in minutes	Time spent reading emails in minutes	Time spent playing games on the internet in minutes	Time spent on YouTube in minutes	Time spent on Internet browsing in minutes	Time spent on Coursework in minutes	Time spent talking on cell phone in minutes	Time spent texting on cell phone in minutes	Time spent browsing internet on cell phone in minutes	Total number of hours spent on technology
Time spent on Facebook in minutes	Pearson Correlation	1	.059	.068	.080	.113	.507**	.278**	-.048	.161*	.460**	.569**
	Sig. (2-tailed)		.427	.361	.280	.129	.000	.000	.523	.030	.000	.000
	N	183	183	183	183	182	181	180	182	183	182	183
Time spent on Twitter in minutes	Pearson Correlation	.059	1	.004	-.092	.136	.064	.033	-.117	.159*	.037	.236**
	Sig. (2-tailed)	.427		.962	.216	.066	.393	.658	.115	.032	.619	.001
	N	183	183	183	183	182	181	180	182	183	182	183
Time spent reading emails in minutes	Pearson Correlation	.068	.004	1	.170*	.078	.097	.159*	.060	.020	.129	.205**
	Sig. (2-tailed)	.361	.962		.021	.294	.195	.033	.425	.790	.082	.005
	N	183	183	183	183	182	181	180	182	183	182	183
Time spent playing games on the internet in minutes	Pearson Correlation	.080	-.092	.170*	1	.137	.285**	-.018	.064	-.045	.047	.179*
	Sig. (2-tailed)	.280	.216	.021		.064	.000	.806	.394	.549	.530	.015
	N	183	183	183	183	182	181	180	182	183	182	183
Time spent on YouTube in minutes	Pearson Correlation	.113	.136	.078	.137	1	.361**	.309**	-.028	.152*	.088	.491**
	Sig. (2-tailed)	.129	.066	.294	.064		.000	.000	.711	.040	.237	.000
	N	182	182	182	182	182	181	179	181	182	181	182
Time spent on Internet browsing in minutes	Pearson Correlation	.507**	.064	.097	.285**	.361**	1	.378**	.019	.107	.410**	.682**
	Sig. (2-tailed)	.000	.393	.195	.000	.000		.000	.804	.152	.000	.000
	N	181	181	181	181	181	181	179	180	181	180	181
Time spent on Coursework in minutes	Pearson Correlation	.278**	.033	.159*	-.018	.309**	.378**	1	.029	.106	.207**	.610**
	Sig. (2-tailed)	.000	.658	.033	.806	.000	.000		.699	.156	.005	.000
	N	180	180	180	180	179	179	180	179	180	180	180
Time spent talking on cell phone in minutes	Pearson Correlation	-.048	-.117	.060	.064	-.028	.019	.029	1	.027	.152*	.129
	Sig. (2-tailed)	.523	.115	.425	.394	.711	.804	.699		.714	.041	.082
	N	182	182	182	182	181	180	179	182	182	181	182
Time spent texting on cell phone in minutes	Pearson Correlation	.161*	.159*	.020	-.045	.152*	.107	.106	.027	1	.129	.644**
	Sig. (2-tailed)	.030	.032	.790	.549	.040	.152	.156	.714		.083	.000
	N	183	183	183	183	182	181	180	182	183	182	183
Time spent browsing internet on cell phone in minutes	Pearson Correlation	.460**	.037	.129	.047	.088	.410**	.207**	.152*	.129	1	.500**
	Sig. (2-tailed)	.000	.619	.082	.530	.237	.000	.005	.041	.083		.000
	N	182	182	182	182	181	180	180	181	182	182	182
Total number of hours spent on technology	Pearson Correlation	.569**	.236**	.205**	.179*	.491**	.682**	.610**	.129	.644**	.500**	1
	Sig. (2-tailed)	.000	.001	.005	.015	.000	.000	.000	.082	.000	.000	
	N	183	183	183	183	182	181	180	182	183	182	183

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

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

a. Sex, male and female = female

Physical Health, Pain/Discomfort (neck, shoulders, hands, wrists), Eye discomfort, Headaches/Migraines

This section provides the reader with an overview of the findings related to outcomes alloted to exposure to VDTs. Table 4.5 (below) highlights the sex-specific outcomes related to physical health outcomes including physical pain/discomfort in the neck, shoulders and wrists, eye discomfort and headaches/migraines. These results were obtained using a Visual Analogue Scale (VAS) with values ranging from 1 (low) to 10 (high). The p-values were obtained by Student t-tests (2 tailed test, $p < 0.05$ deemed to be significant a priori). The values in the tabular columns represent mean values and standard deviations. Although not significant, on average males reported being more physically healthy (7.56±1.49), when compared to females (7.22±1.54, p=0.08). Females reported significantly more physical pain/discomfort in the neck, shoulders and wrist regions in comparison to their male counterparts (4.40±2.35 and 3.69±2.59, respectively, $p \leq 0.05$). Additionally, females reported a significant mean increase in headaches/migraines (4.58±2.79, $p \leq 0.01$); as well as a mean increase in eye discomfort (4.94±2.45, $p \leq 0.05$) when compared to males (3.52±2.71) and (4.20±2.33), respectively.

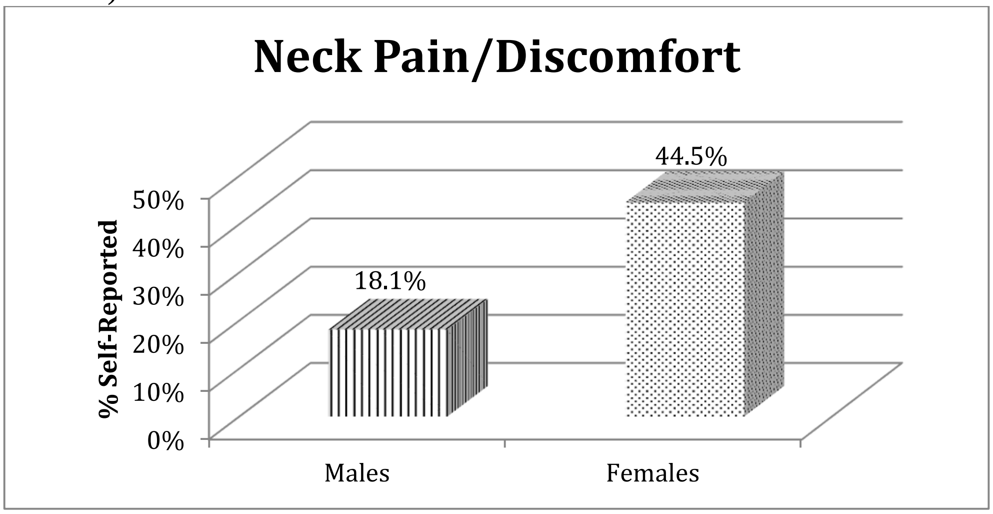
Table 4.5: Sex-specific Outcomes

Variables	Males	Females	p-values
Physical Health	7.56±1.49	7.22±1.54	0.08
Mental Health	7.97±1.60	7.85±1.69	0.58
Overall Physical pain (neck, shoulders, wrists)	3.69±2.59	4.40±2.35	0.02*
Mental stress/Anxiety	4.94±2.52	5.38±2.45	0.16
Eye Discomfort	4.20±2.33	4.94±2.45	0.02*
Headaches/Migraines	3.52±2.71	4.58±2.79	0.003**
Dependence on Technology	6.47±2.71	6.86±2.47	0.19

Note: All values shown are $\overline{X}$±S.D. ** indicates $p \leq 0.01$, * indicates $p \leq 0.05$

Figure 4.2 (below) provides the reader with a graphic representation of differences observed in the location of pain between males and females. These results were obtained using the Nordic Musculoskeletal Questionnaire (NMQ) detailed in chapter 3. A Chi-squared test was done to analyze the data obtained. The findings revealed that overall, females suffered significantly more pain in the neck/shoulder/hand and wrist compared to males (64.1% and 45.7%, respectively) (χ^2=18.463, df =2, $p<0.01$). Figure 4.2 (below) summarizes for the reader the percentage of neck pain reported by males and females. It was found that 44.5% of females (N=81) experienced occasional pain in the neck when compared to males (18.1%, N=17, $p \leq 0.01$).

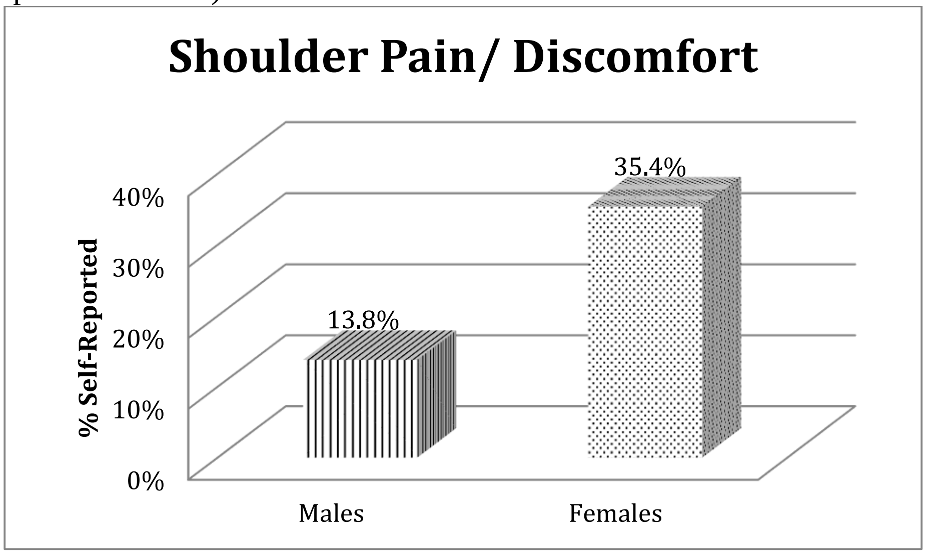
Figure. 4.2 Sex-specific Location of Pain Using the Nordic Scale (% pain in specific location)



Note: Total number of males = 94; females = 182, $p \leq 0.01$

Similarly, Figure 4.3 (below) shows that approximately 35.4% (N = 64) of female university students reported significant pain in the shoulders, compared to only 13.8% (N = 13) of their male subjects ($p \leq 0.01$).

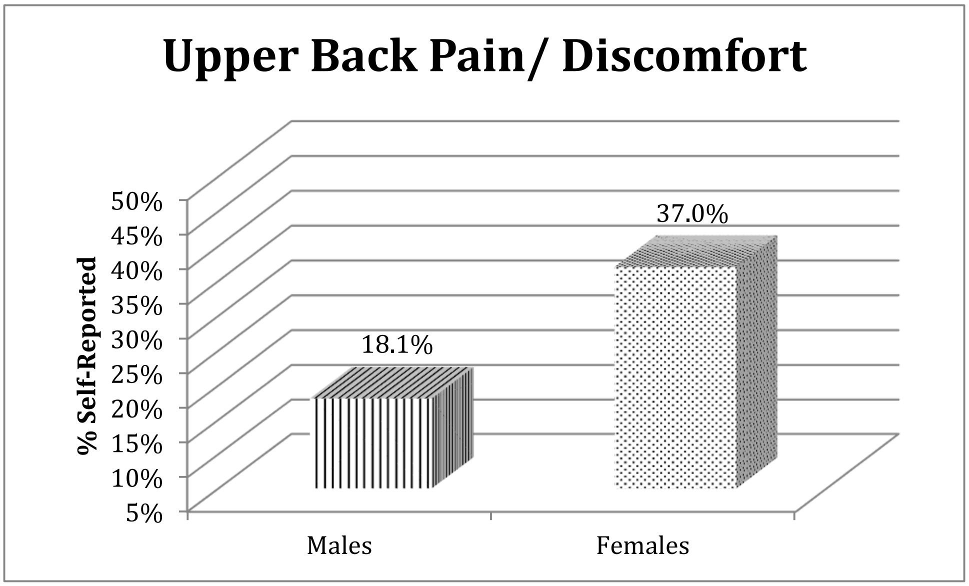
Figure 4.3: Sex-specific Location of Pain Using the Nordic Scale (% pain in specific location)



Note: Total Number of males = 94; Females = 181, $p \leq 0.01$

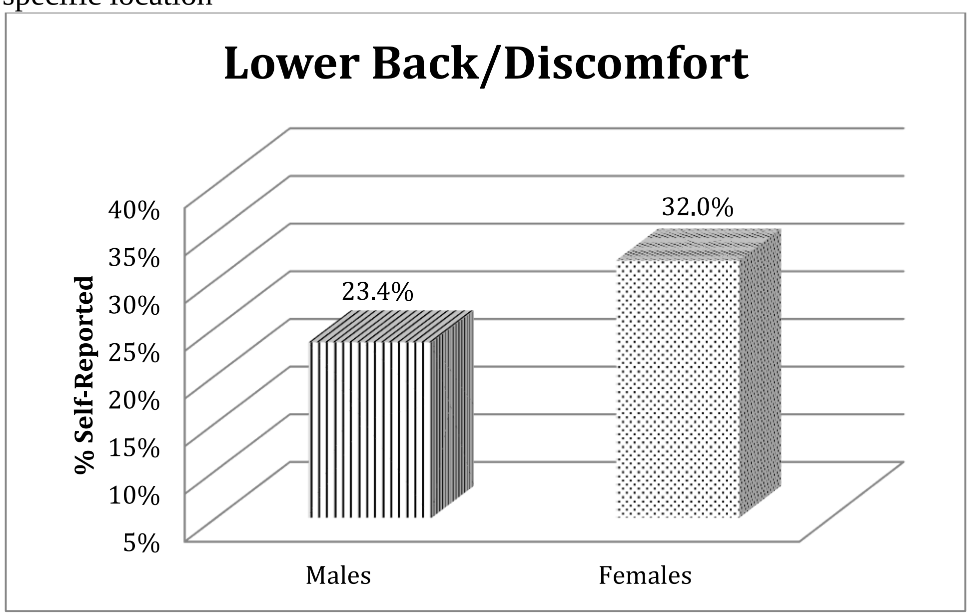
Figures 4.4 and 4.5 (below) reports the percentage of pain suffered in the back attributed to VDT use. These findings suggest a significant increase in the percentage of female students with upper back pain (37%, N = 37), compared to males (18.1%, N = 18, $p \leq 0.01$). Additionally, 32% (N = 58) of females reported experiencing moderately significant pain in the lower back, compared to 23.4% (N = 22, $p = 0.08$) of males who reported pain in the same region.

Figure 4.4: Sex-specific Location of Pain Using The Nordic Scale (% pain in specific location)



Note: Total Number of males = 94; Females = 181; $p \leq 0.01$

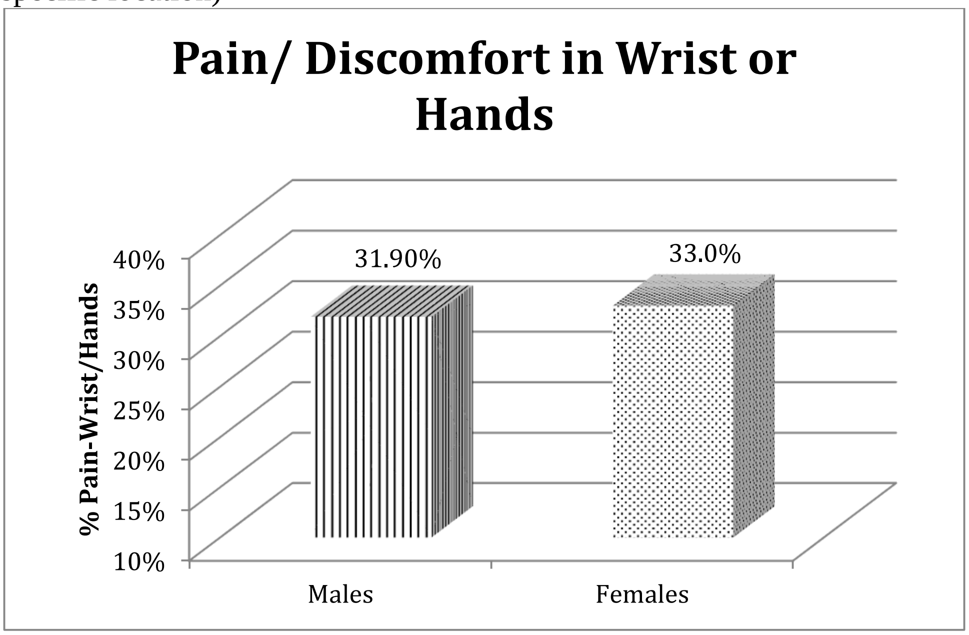
Figure 4.5: Sex-specific Location of Pain Using the Nordic Scale (% pain in specific location



Note: Total Number of males = 94, Females = 181; $p = 0.08$

Figure 4.6 (below) shows the percentage of pain/discomfort reported in the wrists and hands for male and female students. Approximately 33% (N = 59) of female university students reported significant pain in the wrist/hands, in comparison to their male counterparts (31.9%) (N = 30, $p \leq 0.05$).

Figure 4.6: Sex-specific Location of Pain Using the Nordic Scale (% pain in specific location)



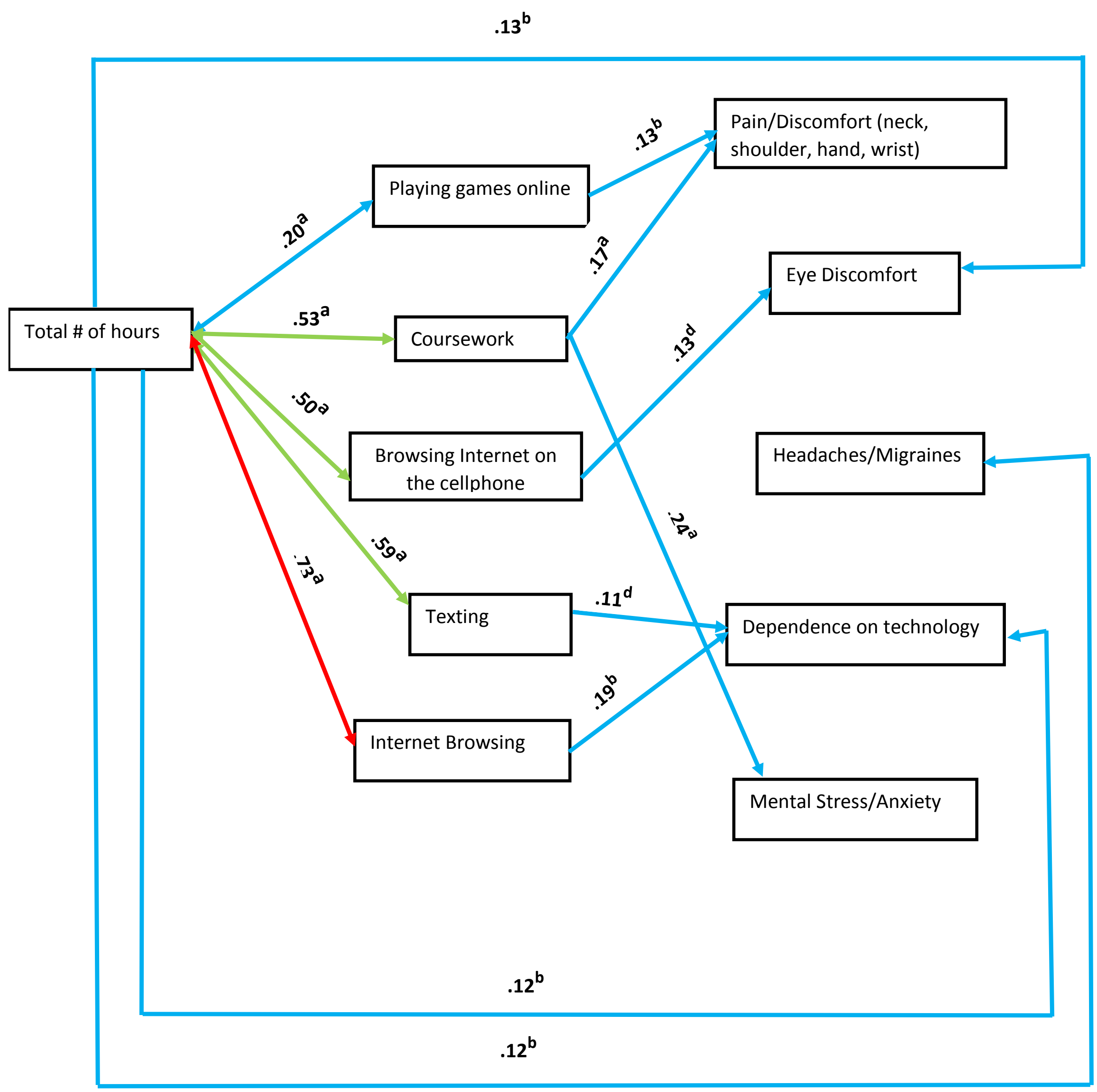
Note: Total Number of Males = 94; Females = 179; $p \leq 0.05$

Figure 4. 7 (below) demonstrates to the reader the results from a post hoc path analysis that there are both direct and indirect effects with exposure to VDTs. In this section, the reader is urged to focus on outcomes such as pain/discomfort in the neck, hands, shoulders and wrists, headaches/migraines, and eye discomfort. The direction of the arrows indicate the paths of both direct and indirect effects; results suggest that there is a direct effect between the total number of hours in front of a VDT and observed headaches/migraines and eye discomfort and this is quantified by the standardized regression coefficient (β =.12, $p \leq 0.05$) and (β =.13, $p \leq 0.05$), respectively. Additionally, there is an indirect effect of exposure to VDTs (measured by total number

of hours in front of a VDT) and pain/discomfort in the neck, shoulder, hand and wrist via coursework obtained by multiplying the standardized regression coefficient of path leading to coursework online from total VDT exposure (measured in hours) with the path leading to pain/discomfort in neck, shoulders, hands and wrists (.09); Similarly, an indirect effect is observed on pain/discomfort in the neck, shoulders, hands and wrists via online gaming (.03). The total indirect effect of exposure to VDT (measured as the total number of hours in front of a VDT) is the sum of all individual indirect effects, i.e. (coursework and playing games online); this was found to be .12. The total effect of exposure to VDTs (measured in terms of hours in front of a VDT) on pain/discomfort in the neck, shoulders, hands and wrists is the sum of the all indirect effects on the outcome as no direct effect was found; this was found to be 0.12. The total effect (both direct and indirect effects) of exposure to VDTs and physical health including physical pain/discomfort in the neck, shoulders, hands and wrist, headaches/migraines and eye discomfort was found to be .37.

Combined

Fig. 4.7: Path Analysis showing significant relationships between total number of hours (measured in total minutes) and outcomes



Legend: a=p<0.01; b=p<0.05; d=p<0.10

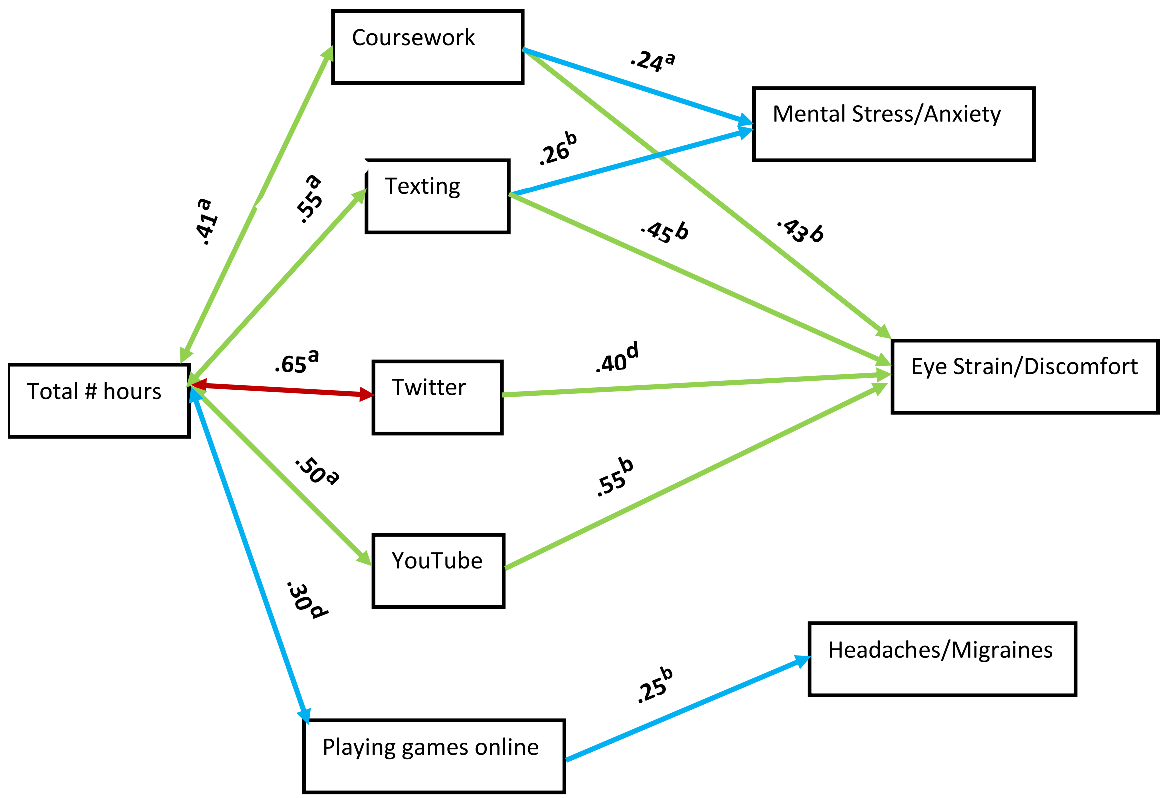
Note: The numbers shown are path coefficients, which are standardized partial regression slopes. The figure shown is recursive model, meaning that the causal flow is unidirectional and without feedback loops.

Path analysis is a regression based procedure for testing causal models which are typically comprised of non-experimental data as in this case, where I utilized survey data. Based on results obtained in table 4.1, only variables that were deemed statistically significant were included in my path analysis. I acknowledge that path analysis is not a method for discovering cause per se rather is a method applied to a pre-specified model formulated on the basis of prior knowledge and my literature review (Loiselle & Profetto-McGrath, 2011)

Figure 4.8 (below) directs the reader to a secondary path analysis done to compare male and female subjects with regards to various health outcomes such as pain/discomfort in the neck, shoulder, hands and wrists, headache/migraines, and eye discomfort. Results revealed that the total number of hours in front of a VDT had no direct effects among males. However, the indirect outcomes observed were from coursework, texting, Twitter ™, YouTube ™ as well as playing games online. The indirect effects via coursework was found to be .18. This was obtained by multiplying the standard regression coefficients of coursework online ($\beta = 0.41$) with the standard regression coefficient for eye discomfort ($\beta = 0.43$). Similarly, the indirect effects of VDT exposure (measured by total number of hours in front of a VDT) for eye discomfort via texting was found to be .25. The indirect effect of VDT exposure on eyestrain via Twitter ™ was found to be .26, while the indirect effect observed on eyestrain from VDT exposure via YouTube ™ was .28. Total indirect effects from the variables examined was found to be .97. Additionally, the indirect effect observed with VDT exposure for headaches/migraines via playing games online was found to be .08.

Males

Fig. 4.8: Path Analysis showing significant relationships between total number of hours (measured in total minutes) and outcomes



Legend: a=p<0.01; b=p<0.05; d=p<0.10

Note: The numbers shown are path coefficients, which are standardized partial regression slopes. The figure shown is recursive model, meaning that the causal flow is unidirectional and without feedback loops.

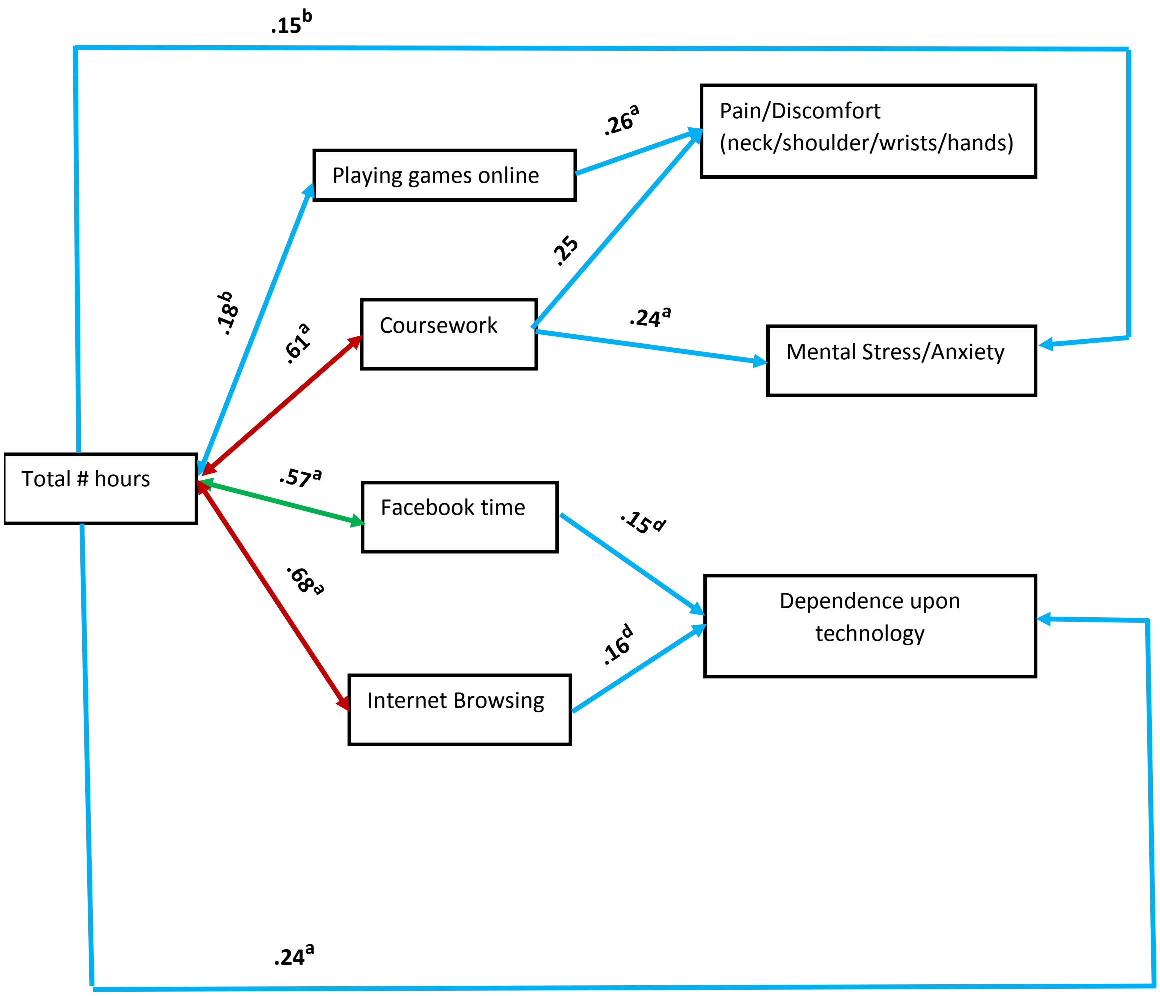
In comparison to the above, Figure 4.9 (below) shows a secondary path analysis done for females with regards to the same outcomes outlined in the previous paragraph. It was found that VDT exposure had an indirect effect on pain/discomfort in the neck, shoulders, hands and wrists through two different routes. The first is via playing games online where the indirect effect amounted to be .05 (obtained by multiplying the standard regression coefficients ($\beta = .18$) and ($\beta = .26$), respectively (see Fig. 4.9). Secondly, the indirect effects that VDT exposure had on pain/discomfort (neck, shoulders, hands, wrists) via coursework was found to be .15. The total indirect effects that were observed via playing games online and coursework was the sum of the individual indirect effects, (i.e., .2).

Mental Health Including Mental Stress/Anxiety and Psychosocial Factors

This section provides the reader with an overview on the effects of exposure to VDTs for the mental health and well-being of the students being exposed, including mental stress/anxiety, dependence on technology, and psychosocial factors including loneliness, addiction to VDTs (i.e. no time left for other social activities, staying online longer than intended, schoolwork suffering, loss of sleep). Although found not to be statistically significant, Table 4.1 (above) suggests that females spent more time online, when compared to males (846.57±445.27 and 750.02±571.60, respectively).

Females

Fig. 4.9: Path Analysis showing significant relationships between total number of hours (measured in total minutes) and outcomes



Legend: a=p<0.01; b=p<0.05; c=p=.05; d=p<0.10

Note: The numbers shown are path coefficients, which are standardized partial regression slopes. The figure shown is recursive model, meaning that the causal flow is unidirectional and without feedback loops.

Table 4.5 (above) indicates that male students have slightly better mental health, when compared to their female counterparts although this was not significant (7.97±1.60 and 7.85±1.69). Additionally, it also suggests that female students experience increased amounts of mental stress/anxiety in comparison to male students (5.38±2.45 and 4.94±2.52, respectively). Moreover, there was a slight but insignificant increase in dependence on technology amongst female students, when compared to their male counterparts (6.86±2.47 and 6.47±2.71, respectively). Table 4.2 (above) provides the reader with the results of a Pearson's correlation which revealed that there was a weak but significant positive correlation between the total number of hours spent in front of a VDT and dependence upon technology ($r=.12.\ p \leq 0.05$).

Figure 4.7 (above) directs the reader to a post-hoc path analysis that revealed an indirect effect for the total number of hours spent in front of the VDT on mental stress/anxiety via coursework done online that was approximately .15, (obtained by multiplying the standard regression coefficients of coursework and mental stress/anxiety ($\beta = .53$ and $\beta = .24$, respectively)). With regards to dependence upon technology, it was found to be directly affected by the total number of hours in front of a VDT ($r=.12.\ p \leq 0.05$). Dependence upon technology was indirectly affected by total number of hours spent in front of a VDT via texting (.07) and Internet browsing (.14). The total indirect effects of VDT exposure on dependence upon technology was the sum of individual indirect effects, namely, texting and Internet browsing (.21). The total effects of VDT exposure on dependence was the sum of all direct and indirect effects, and that was found to be .33.

Figure 4.8 (above) draws the reader's attention to a secondary path analysis which revealed that exposure to VDTs (measured by the total number of hours spent in front of a VDT) had an indirect effect on mental stress/anxiety via coursework (.10) and texting(.14) among males students. The total indirect effects of VDT exposure on mental stress/anxiety was .24.

In contrast, amongst females students there was a direct effect of VDT exposure on mental stress/anxiety (.15) (see Figure 4.9). Mental stress/anxiety was also affected indirectly for females via coursework (.15). The total effect of exposure to VDTs on mental anxiety and stress was calculated as the sum total of all direct and indirect effects, (i.e., .30). Additionally, there was a direct effect for exposure to VDTs (measured by the total number of hours spent in front of a VDT) on dependence on technology ($r=.24$, $p \leq 0.01$). There was also indirect effects of VDT exposure via Internet browsing (.11) and time spent on Facebook ™ (.09). The total indirect effects of exposure to VDT via Internet browsing and Facebook ™ time was calculated to be .20. The total effect of exposure to VDTs on dependence on technology was the sum of all indirect and direct effects (.44).

A chi-squared test revealed that although not significant, approximately 60.1% of female university students reported their schoolwork suffered because of computer/laptop/cell phone use, in comparison to 51.6% of their male subjects. Moreover, approximately 44.2% of female students reported exhaustion from computer/laptop/cell phone use, in comparison to 41.5% of male students (this result was also not significant). Both male and female university students reported (≈17%) choosing to spend moderately significant amounts of time online over going out with others ($\chi^2=9.955$, $df=5$, $p=0.59$).

Summary

In summary, these preliminary findings suggest that prolonged exposure to VDTs may predispose university students to a host of negative physical and mental health issues including increased pain/discomfort, headaches/migraines, eye discomfort, mental stress/anxiety, and increased dependence upon technology. The primary source of VDT exposure for both male and female university students was browsing on the Internet. An interesting finding in this study was that although males were more inclined to be playing games online in comparison to females, it had a direct effect on pain/discomfort in the neck, shoulders, hands and wrists among female students exclusively. Moreover, playing games online had a direct effect on headaches/migraines among male students exclusively. Additionally, coursework done online had direct effects on mental stress/anxiety as well as pain/discomfort in the neck, shoulders, hands and wrists among females exclusively. Furthermore, on browsing the Internet via cell phones had a significant direct effect on eye discomfort while browsing the Internet on any device had a direct and significant effect for dependence upon technology among female students alone. Further investigations are warranted to confirm the above findings targeting university students who have prolonged exposure to VDTs due to coursework and routine use of social media and other platforms.

Chapter 5

Discussion/Conclusion

The results of this study add to the growing body of evidence which suggest that exposure to Video Display Terminals (VDTs) result in negative physical and psycho-social outcomes including: (i) Increased stress and anxiety; (ii) sleep disturbances; (iii) muscle pain and discomfort (i.e., neck, shoulder); (iv) eye strain; (v) headaches; (vi) nausea; (vii) restlessness; (viii) loneliness, and (ix) isolation (e.g., Balci & Aghazadeh, 2003; Hsu & Wong, 2013; Kormas et al., 2011; Nakazawa et al., 2003; Tomei et al., 2006; Yoo and An, 2009). The aim of the study was to examine potential negative health effects associated with exposure to a mobile electronic or digital devices and technologies with a VDTs (e.g., laptops, cell phones, tablets, iPods) by undergraduate university students in the Oshawa, Ontario. To my knowledge this is the first study to examine the health effects related to cumulative VDT exposures amongst university students in Canada.

High-end users are defined in the literature as those who use a VDT for prolonged periods of time (≥ 5 hours) (Ye et al. 2007b; Nakazawa et al. 2002). In this study, results indicate that university students collectively spend a prolonged amount of time exposed to VDTs in general. Specifically, a strong positive correlation was found between VDT exposure and Internet browsing. Moreover, moderate correlations between VDT exposure and the following activities were found: (i) Texting; (ii) coursework online; (iii) watching YouTube, and (iv) browsing the Internet on the cellphone. Although not statistically significant, the current study found that female subjects reported increased exposure to VDTs, in comparison to their male counterparts as measured by the total number of hours spent in front of a VDT device. Notably, females spent significantly increased amounts of time exposed to VDTs while doing coursework online or texting on their cellular or smartphones.

Hypothesis 1

Hypothesis 1 stated that female students who use VDTs will complain of increased physical pain and discomfort (e.g., neck, shoulder, back), in comparison male students. Based on the results of this study, hypothesis 1 is supported. The results indicated that university students experience pain and discomfort in the neck, shoulders, hands and wrists regions. These findings are consistent with a study by Fogleman and Lewis (2002) who reported that the single most important risk factor identified for discomfort was the number of hours spent in front of a computer workstation (for all body regions). Moreover, a study by Hakala et al (2010) suggests that one hour of computer use daily was associated with an increase in complaints with respect to upper extremity symptomatology (neck, shoulders, hands, fingers and wrists). In addition, more than 4 hours of daily computer use was associated with negative health symptoms in various body regions including the eyes, the head and lower back.

In the present study a direct association between increased exposure to VDTs and eye discomfort was found. This difference may be due to the fact that Hakala et al. (2010) aimed to study the effect of ergonomic instruction on the reduction of computer-related health complaints. Moreover, Hakala et al., (2010) stated that there was only a small number of adolescents who reported computer use of $\geq$ 4 hours in their investigation.

Since the present study examined various types of electronic devices equipped with VDTs, there is a collective and cumulative increase in the reporting of exposure to VDTs. Hsu and Wang (2003) reported an overall prevalence of upper extremity discomfort which included the neck, shoulder, upper arm, forearm/elbow, wrist and fingers. In my study, the reported pain and discomfort was divided into specific body regions such as neck, shoulder, upper back, lower back, hands and wrists. Specifically, I found that females reported increased pain and discomfort in the neck region whereas males reported increased pain in the hands and wrists.

The results are consistent with Berolo, Wells and Amick (2011) who examined pain and discomfort in different body regions. Although their findings did not explicitly report differences between the sexes with regard to pain and discomfort, the body regions in which pain was reported was consistent with the order of pain and discomfort reported in the different regions of the body among female university students in my study. However, Berolo et al. (2011) only examined hand-held devices exclusively whereas my study examined exposure to VDT from a variety of electronic devices (e.g., cellular phones, tablets, laptops).

The results from my study are also consistent with that of Klussmann et al. (2008) who reported that females had more neck pain/discomfort when compared to males. Notably, the findings of my study revealed a positive correlation between coursework done online, playing games online and pain/discomfort in the neck, shoulders/wrist/hands. My findings are also consistent with the findings of Berolo, Wells, and Amick (2011) who reported pain in the upper extremities (particularly, the middle of the right thumb). However, the specific aim of my study was not to identify pain in the different regions of the hand/arm per se. Taken together, results from these studies and my current investigation suggest a strong link between prolonged VDT use and associated pain/discomfort in different body regions.

Hypothesis 2

Hypothesis 2 stated that female students who use VDTs will complain of increased mental stress and anxiety, in comparison to male students.

Based on the results from my study, this hypothesis is supported. Nakazawa et al. (2002) reported increased mental health symptoms when exposed to VDTs for more than 5 hours. In contrast to the above findings, Travers and Stanton (2002) found that VDT users reported lower mean anxiety, depression and hostility scores. This difference may be due to increased levels of job satisfaction in their study population. Balci and Aghazadeh (2002) reported that the type of task performed may influence psychological states. For example, mental arithmetic tasks resulted in poorer performance scores and higher complaints of psychological discomfort. Similarly, Ye et al. (2007) reported significant increased psychological distress resulting from exposure to VDTs for more than 5 hours per day.

In my study, female students reported that they spend increased amount of time in front of a VDT, in comparison to their male counterparts. Although statistically not significant, findings from my study indicate increased self-reports of mental stress and anxiety among female subjects, when compared to males. This finding is consistent with those of Kubo et al. (2006), who reported an increased incidence of symptoms consistent with Sick Building Syndrome (SBS) among females who were exposed to VDTs for longer than 2 hours, in comparison to male workers. Moreover, the prevalence of SBS increased with concomitant increases in the total number of hours exposed to VDTs. Thomée et al. (2011) suggested that high mobile phone use may be a risk factor for depressive symptoms in both men and women. However, their study concentrated on mobile phone use which included calling, receiving calls as well as text messaging. In contrast, my study examined various modes of VDT use, including, Internet use; texting; accessing YouTube; talking on the cell phone; playing games online; reading e-mails; accessing Facebook ™, and doing coursework online.

In a study by Tomei et al. (2006), 200 clerical workers were examined for work-related stress. The researchers found a significant increase in stress and anxiety levels in female VDT workers. The results of my study are consistent with the findings of Tomei et al (2006), although my study concentrated on university students per se. Similarly, a study by Sanchez-Martinez and Otero (2009) supports the findings of my study on university students who reported that females had a higher percentage of cell phone possession. These findings are consistent with my study since females reported spending more time in front of VDTs. In addition, more females were reported to send text messages in comparison to their male counterparts. Increases in cell phone use was also found to be positively associated with depressive symptomatology. In my study, females reported significantly increased amounts of time spent online, primarily related to coursework followed by texting. My results indicated a strong positive association between online coursework, texting and the total number of hours exposed to VDTs (measured in minutes). Female students also reported increased amounts of mental stress and anxiety, when compared to their male counterparts. In addition, exposure to VDTs (measured as of total number of minutes spent in front of VDTs) was reported to have an indirect but positive effect on male subjects in my study.

The results of my study are consistent with the findings of Thomée (2014) who reported a rise in mental stress and depressive symptomatology associated with increased use of information and communication technology. Notably, men reported increased sleep disturbances associated with longer durations of computer use and increased frequency of mobile phone use. Interestingly, men reported depressive symptomatology associated with increased frequency of mobile phone use. Similarly, women reported depressive symptomatology with increased frequency of mobile phone use. Extended durations of computer use was also reported to be associated with increased risk of mental stress, sleep disturbances, and symptoms of depression in women. Moreover, excessive e-mailing/chatting was associated with increased self-reported sleep disturbances in both sexes. The results of my study are consistent with these findings which also revealed an increase in the mental stress/anxiety. This was found to be more prominent in females, compared to males. However, in contrast to the detailed findings of Thomée (2014), my study presented a general overview of mental stress/anxiety as a result of prolonged VDT exposure. Taken together, these findings suggest an increased association between mental stress and anxiety and exposure to VDTs, especially for female students.

Hypothesis 3

Hypothesis 3 stated that female students who use VDTs will complain of increased eye discomfort (e.g. eyestrain, blurred vision/double vision, redness of eyes) in comparison to male students. Based on the results of my study, hypothesis 3 is fully supported because the results revealed a direct positive association between exposure to VDTs (measured by total number of minutes exposed to VDTs) and eye discomfort in university students. Notably, my results revealed a significant increase in complaints of eye discomfort among female subjects, in comparison to male subjects. My findings are consistent with those reported by Hakala et al. (2010), Lin et al. (2008), Travers and Stanton (2002), and Uchino et al. (2011). However, my study is the first to examine this phenomenon in university students to my knowledge.

Hakala et al. (2010) reported a statistically significant relationship between computer use and eye discomfort. Particularly, eye discomfort was seen with prolonged exposure of more than 4 hours. Taking viewing distance into consideration, Hsu and Wang (2003) reported increased visual strain as screen distances decreased. Contrary to the study done by Hakala et al. (2010), Travers and Stanton (2002) found that viewing distances had no effect on eye symptomatology. They argued that screen reflection was associated with eye-fatigue. Lin et al. (2008) reported a decrease in visual acuity in red light. Low levels of lighting were also found to induce visual fatigue. However, I did not differentiate between the various types of lighting present or viewing distances in my investigation. The results of my study, nonetheless, revealed increases in visual and eye discomfort in general.

A study done by Uchino et al. (2011) reported increased prevalence of Dry Eye Disease (DED) among female VDT users. Severe DED was more common in females and was associated with longer exposures to VDTs. Similarly, Hakala et al. (2010) reported increased complaints of eye symptomatology among females, which also increased in association with age. Although, my findings are consistent with the findings of Uchino et al. (2011) and Hakala et al. (2010) my study focused on millennial university students as the target population of interest. In contrast to my study Uchino et al. (2011) studied office workers while Hakala et al. (2010) focused on young pre-teens and teens ranging from 12-18 years of age.

Hypothesis 4

Hypothesis 4 stated that female students who use VDTs will report increased levels of addiction to technology, in comparison to male students. Based on the results of my study, this hypothesis is fully supported. Specifically, findings from my study indicated that there was a positive correlation between exposure to VDTs (measured by the total number of minutes spent in front of VDTs) and dependence upon technology. Additionally, secondary path analysis revealed a direct positive relationship between exposure to VDTs (measured by the total number of minutes spent in front of VDTs) and self-reported dependence upon technology (i.e., Internet addiction). Although not statistically significant, female subjects reported spending more time in front of VDTs. Specifically, female students reported spending significantly more time online doing coursework and texting; whereas males reported spending significantly more time playing games online. There was also a strong positive correlation found between total number of hours spent using technologies with VDTs (measured in minutes) and Internet browsing for both male and female subjects. Female subjects reported an increased dependence upon the technology (i.e. Internet addiction), although this finding was not found to be statistically significant. Moreover, a higher percentage of female subjects reported that their schoolwork suffered because of computer/laptop/cellphone use, in comparison to male subjects. Interestingly, a higher percentage of female subjects also reported suffering from exhaustion from computer/laptop/cellphone use, in comparison to their male counterparts.

Notably both male and female subjects reported that they preferred to spend more time online versus conventional forms of socializing (i.e., face-to-face meetings, going out with friends). These findings are consistent with those of Morahan-Martin and Schumacher (2003) who reported a statistically significant association between loneliness and Internet use times. Socially isolated and lonely users utilized the Internet to relax, meet people and waste time. Lonely users were also more likely to use the Internet to communicate with people rather than engaging in face-to-face communications. Similar to the findings by Morhan-Martin et al. (2003), my results showed that female subjects reported increased exposure times to VDTs in general.

Additionally, there was a strong positive correlation between female subjects and Internet browsing. This suggests that females may be more inclined to socialize online versus conventional face-to-face meetings. Indeed, secondary path analysis revealed an indirect relationship between exposure to VDTs (measured by total number of hours spent in front of VDTs) and dependence upon technology via Internet browsing and time spent on the social media site, Facebook ™, among female subjects. Interestingly, there was also a strong positive correlation between Facebook™ use and exposure to VDTs among male subjects. Although these findings are consistent with those by Nakazawa et al. (2002), my study also took into account problems associated with schoolwork due to increased cellphone/laptop/computer use in addition to self-reports of exhaustion. Moreover, Nakazawa et al. (2002) studied a population of clerical office workers while my study targeted university students per se. The results from my study are also consistent with those of Sanchez-Martinez and Otero (2009) who reported an increased dependency on cellphones among young female subjects, aged 20-25 years. In contrast to Sanchez-Martinez et al. (2009), my study took into account dependency upon use of various technologies including cellphones, laptops, computers, and tablets. My study also took into consideration a variety of technological usages and applications such as texting, Internet browsing, social media usage, course-based use of technology, online gaming, e-mails and YouTube. Conversely, the investigation by Sanchez-Martinez et al. (2009) focused on texting, and talking on cellphone devices only.

Hypothesis 5

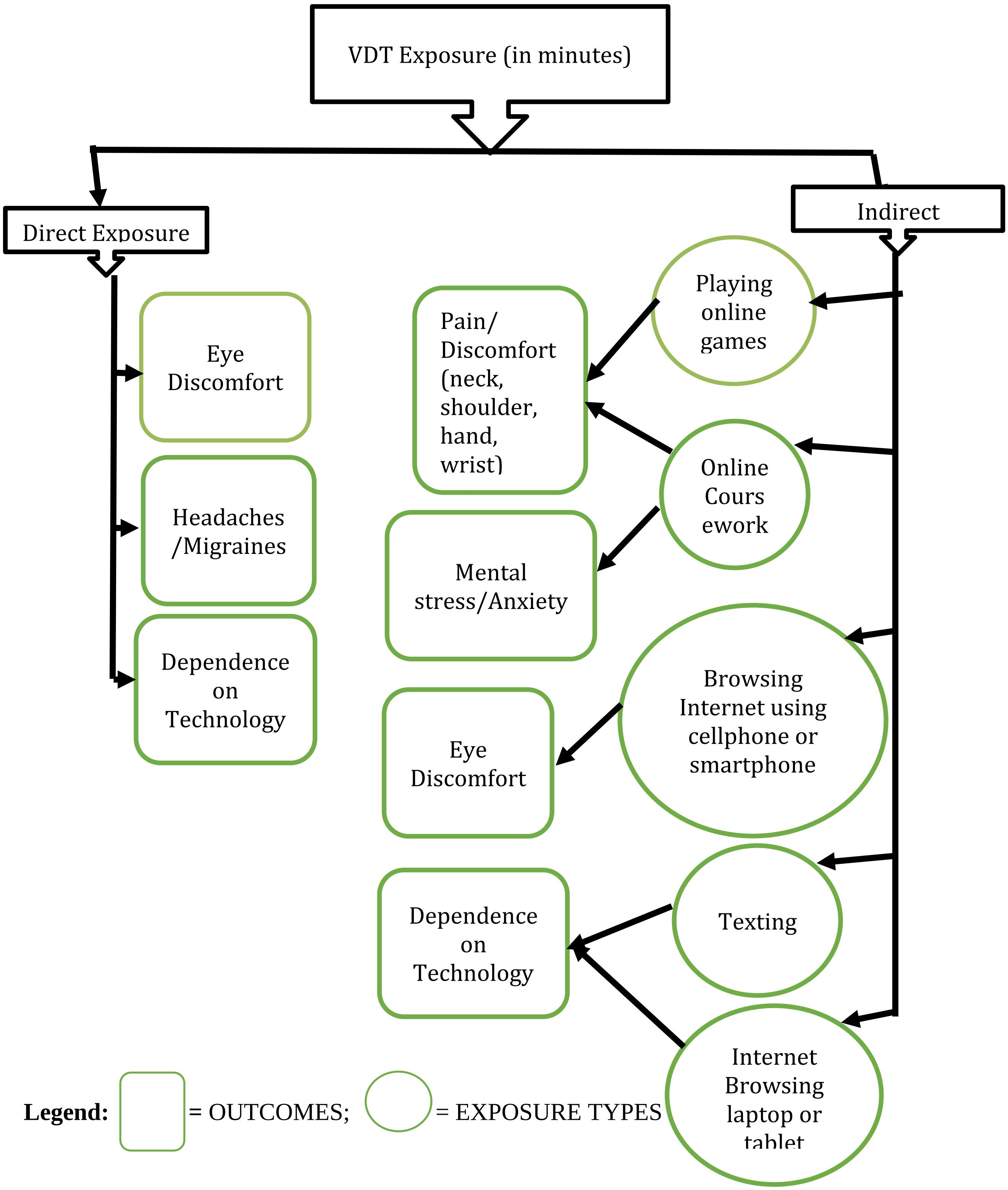
Hypothesis 5 stated that female students who use VDTs will complain of increased headaches and migraines in comparison to male students. Based on the results obtained from my study, this hypothesis is supported. Specifically, my results revealed a direct positive relationship between exposure to VDTs (measured by the total number of hours spent in front of VDTs), and the occurrence of self-reported headaches and migraines. My results are consistent with those of Nakazawa et al. (2002) who reported an increase in physical symptoms including headaches, with increased durations of VDT use. In contrast to Nakazawa et al. (2002), my study did not compartmentalize headaches as part of an array of physical symptomatology which included headaches, eyestrain, bone pain, stiff shoulders, low back pain, and general fatigue. Nevertheless, headaches were among the top 3 complaints in the array of physical symptomatology examined by Nakazawa et al (2002).

Similarly, Hakala et al. (2010) reported a strong positive association between computer-related health complaints including pain, and aches and discomfort in the neck, shoulders, hands, fingers, wrists, lower back, head and eyes. Particularly, headaches were found to be most commonly reported with more than 4 hours of VDT exposure. A study done by Lyon et al. (2003) reported a statistically significant increase in the number of headaches reported with more than 5 hours of office work with associated VDT use. In my study, a secondary analysis examined the differences between the sexes with regards to the occurrence of self-reported headaches. My results revealed a statistically significant increase in the occurrence of headaches among female subjects, in comparison to males. My findings are consistent with those of Hakala et al. (2010) who reported that the prevalence of health complaints, including headaches were more frequent among females than males, and the prevalence also increased with age.

My study is also consistent with those of Clark, Frith and Demi (2004) who conducted a survey of college students across one university campus in the United States. The researchers found that participants reported headaches along with other physical symptomatologies such as eyestrain, neck, back and wrist pain. This study, however, included predominantly Caucasian and females as their study target population. I wish to note that the university where my subjects were recruited is racially and ethnically diverse and both male and female subjects took part in my study. Interestingly, my study found that there was an indirect association between exposure to VDTs (measured by the total number of hours spent in front of a VDT) and headaches/migraines when playing games online for male subjects. However, no such association, direct or indirect, was found amongst female students. Taken together, these results suggests an association between VDT exposure and self-reported complaints of headaches/migraines.

Preliminary general conceptual model with respect to VDT exposure and negative health effects

Fig. 5.1. Preliminary Conceptual Model showing direct and indirect effects of VDT Exposure



Note: The figure shown is recursive model, meaning that the causal flow is unidirectional and without feedback loops. The variables chosen were based on variables found to be statistically significant in Table 4.1 only and subsequent path analysis conducted (Figures 4.1 & 4.2).

Figure 5.1 above is a conceptual diagram of the proposed negative health effects associated with prolonged exposure to VDTs. A preliminary conceptual model is proposed based on my results obtained and path analysis reported in chapter 4. The direction of the arrows indicate the proposed relationship paths for both direct and indirect health effects. Notably, my results suggest direct effects associated with exposure to VDTs, which results in headache/migraine, dependence on technology and eye discomfort. Outcomes such as pain/discomfort in the neck, shoulders, hands and wrists, dependence upon technology were also found to be indirectly influenced via playing games online, online coursework, texting, browsing on the Internet. Additionally, VDT exposure was found to be associated with eye discomfort indirectly via browsing the Internet on subjects' cellular phones.

Notably, some of the proposed associations in Figure 5.1 may be due to more than one variable and exposure source. For example, pain/discomfort experienced in the neck, shoulders, hands and wrists where found to be indirectly associated with exposures such as online coursework and playing games online. Similarly, dependence on technology, was indirectly associated with VDT exposures resulting from texting and browsing on the Internet. Moreover, certain types of exposures were found to be indirectly associated with multiple outcomes. For example, coursework done online was indirectly associated with pain/discomfort in the neck, shoulders, hands and wrists as well as mental stress/anxiety.

Strengths of the study

This study being cross-sectional in design was cost-effective, fast and easy to administer. This is the first Canadian study to propose a preliminary conceptual model for future research on VDT exposure and resultant health effects. Additionally, this is the first study to report cumulative exposure outcomes for VDTs that involve various physical, mental and psychosocial outcomes using a wide range of technological devices including computers, laptops, tablets and cellphones. According to Statistics Canada (2013c) female enrollment into universities has steadily risen to about approximately 60%. Additionally, female enrollment in 2008 was approximately 62%. Therefore, this sample is comparable to national/provincial standards in terms of enrollment trends at Canadian universities in Canada. Lastly, millennials are high-end users of technology and therefore one can argue that they are both comfortable and adept with the use of various devices with VDTs.

Limitations of the study

Since this was a cross-sectional study, causality and temporal order cannot be established. This study used non-random convenience sampling in one particular university in the Durham region of Ontario, Canada. Hence, the results need to be interpreted as preliminary and cannot be used to generalize among all university students and/or millennials. A self-reported questionnaire was also employed in this study. As such this type of questionnaire design is exposed to response style bias and memory (or recall) bias (Bowling, 2005). Response style bias is when the respondent answers the question according to his/her desires and thus may not be accurate or truthful. Memory bias is when a respondent answers a question selectively, conveniently forgetting what he/she desires not to respond to.

Summary and Conclusion

Approximately 45% of youth and young adults are online every day in North America and as of July 2010, Canada had the world's greatest number of Facebook users in proportion to its population; the United Kingdom was second and the USA was third (CEFRIO, 2010; O'Neil, 2012). The results of this study provides preliminary evidence to suggest that increased exposure to VDTs is associated with increased negative health risks and conditions. The results also provide preliminary evidence that there is difference between the sexes with regard to pain, discomfort, anxiety, stress, lack of sleep and loneliness in young Canadian adults in Oshawa, Ontario when exposed to VDTs. However, further multi-centered randomized trials as well as prospective research studies are needed to examine the negative effects of exposure to VDTs in these populations. Particular attention needs to be directed to investigating negative health effects amongst the Canadian millennial population. Additionally, further investigations are needed to test and refine the proposed conceptual model that was proposed in this study.

Currently, there is a dearth of studies which have examined the health effects and outcomes of exposure to various VDT devices especially amongst millennials. This is only the second study to examined health effects due to VDT exposure among Canadian university students. It is notable that the study by Berolo et al. (2011) only focused on musculoskeletal complaints by university students associated with mobile hand-held devices (i.e, cellular and smart phone); whereas my study examined a variety of physical , social, and psychological health effects and outcomes. Particularly, this study examines the health effects related to the use/abuse of technological devices in a university that claims to be a state-of-the-art tech-friendly environment where many if not all courses are delivered to students using modern technology equipped with VDTs.

In summary, my results show that exposure to VDTs had negative health effects and outcomes amongst female as well as male UOIT students who spent more than 5 hours a day exposed to VDTS. The majority of the studies to date have examined the physical effects of exposure to VDTs. Comparatively few studies have chosen to examine psychosocial or mental health effects associated with prolonged exposure to VDTs, especially amongst millennials. The current study is novel and unique because it is the first study, to my knowledge, to examine all the three aspects (i.e. physical, mental and psychosocial) from the uniquely Canadian perspective.

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APPENDIX A

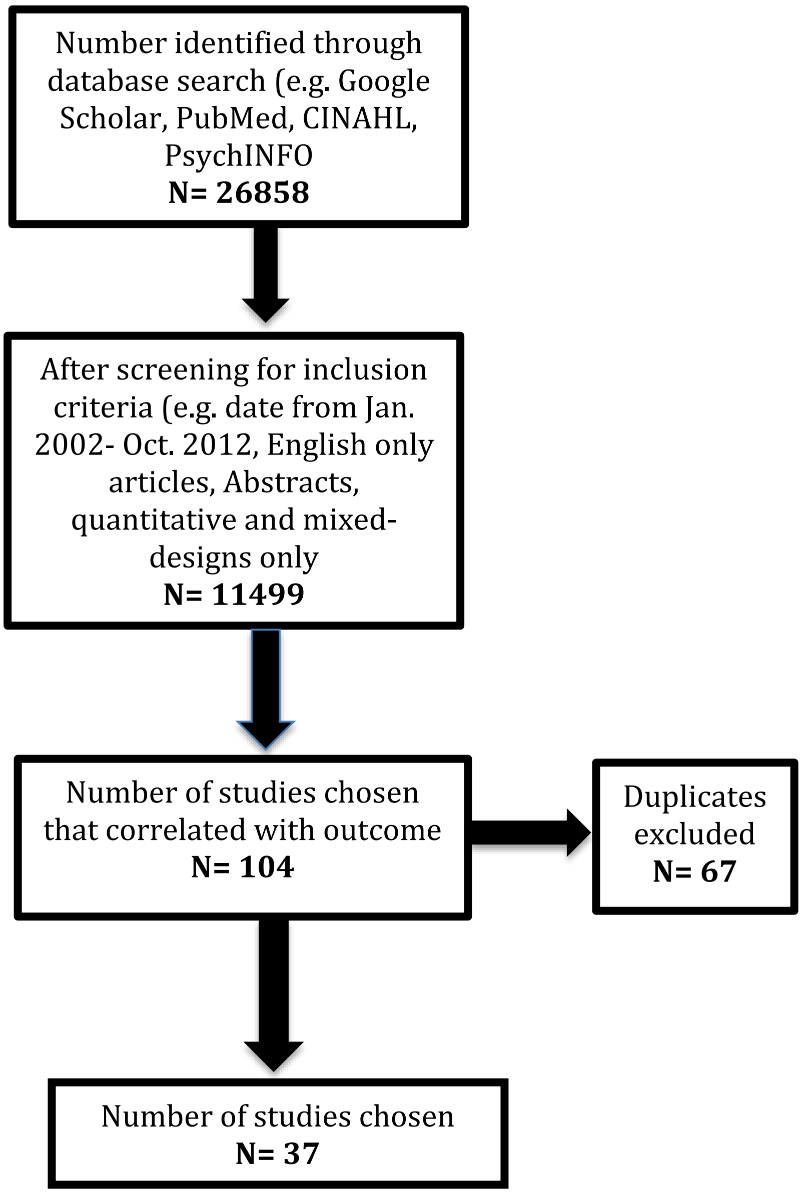

Fig. 1: Flow chart summarizing the systematic review of literature

APPENDIX B

A description of the ranking levels assigned:

Level	Description
I	**Highest Ranking:** Systematic Reviews of RCT's & nonrandomized clinical trials
II	Single RCT or nonrandomized trial
III	Systematic reviews of observational and/or correlational studies
IV	Single observational or correlational study
V	Systematic review of physiological, descriptive or qualitative study
VI	Single physiological, descriptive or qualitative study
VII	**Lowest Ranking:** Opinions by experts in their field, panels or committees

Source: Bartfay W.J. & Bartfay, E. (2013). *Public Health in Canada: Theory and Application (ch.5).* Toronto, Ontario. Pearsons

APPENDIX C

Part I- THE TECHNOLOGY USE AND HEALTH QUESTIONNAIRE

(1)Please list the faculty and program you are in:

Faculty: ________________________ Program: ________________________

(2)Please CIRCLE the year of study in your program

1 2 3 4

(3)What is your current age?______

(4)Are you: (Please circle)

a. Male b. Female

(5) On an average, how much time do you spend on Facebook (or other social media) on a typical day?

a.0 minutes
b.30 minutes
c.1 hour
d.2 hours
e.If more than 2 hours/day, please indicate amount of hours ______

(6)On an average, how much time do you spend on Twitter

a.0 minutes
b.30 minutes
c.1 hour
d.2 hours
e.If more than 2 hours/day, please indicate amount of hours_______

(7)On an average, how much time do you spend reading your e-mails?

a.0 minutes
b.30 minutes
c.1 hour
d.2 hours
e.If more than 2 hours/day, please indicate amount of hours_________

(8) On an average, how much time do you spend playing games on the Internet?

a.0 minutes
b.30 minutes
c.1 hour
d.2 hours
e. If more than 3 hours/day, please indicate amount of hours _________

(9) On an average, how much time do you spend on YouTube?

a.0 minutes
b.30 minutes
c.1 hour

d.2 hours
e.If more than 2 hours/day, please indicate amount of hours ___________

(10) On an average, how much time do you spend browsing the Internet?
a.0 minutes
b.30 minutes
c.1 hour
d.2 hours
e.If more than 2 hours/day, please indicate amount of hours ____________

(11) On an average, how much time do you spend doing your coursework on your computer?
a. 0 minutes
b.30 minutes
c.1 hour
d.2 hours
e.If more than 2 hours/day, please indicate amount of hours ____________

(12) How many cell phones do you own?
a. 0
b. 1
c. 2
d. If more than 2, please indicate number of cell phones _______________

(13) How many electronic devices do you typically carry with you?(cell phone, laptops, tablets)
a. 0
b. 1
c. 2
d. If more than 2, please indicate number of devices _________________

(14) On an average, how much time do you spend talking on your cell phone?
a.0 minutes
b.30 minutes
c.1 hour
d.2 hours
e.If more than 2 hours/day, please indicate amount of hours _____________

(15) On an average, how much time do you spend texting on your cell phone?
a.0 minutes
b.30 minutes
c.1 hour
d.2 hours
e.If more than 2 hours/day, please indicate amount of hours _____________

(16) On an average, how much time do you spend browsing the Internet on your cell phone?
a.0 minutes
b.30 minutes
c.1 hour
d.2 hours
e.If more than 2 hours/day, please indicate amount of hours ________________

<u>Please CIRCLE the choice that best fits your situation or condition</u>

(17) I would currently rate my physical health as:
(Poor) 1 2 3 4 5 6 7 8 9 10 (Excellent)

(18) I would currently rate my mental health as:
(Poor) 1 2 3 4 5 6 7 8 9 10 (Excellent)

(19) I would currently rate my overall physical pain (neck/shoulders/wrists)after having used my computer/laptop/cell phone as:
(Very high) 1 2 3 4 5 6 7 8 9 10 (very low)

(20) I would currently rate my mental stress/anxiety as:
(Very high) 1 2 3 4 5 6 7 8 9 10 (very low)

(21) I would currently rate my eye discomfort level after having used my computer/laptop as:
(High) 1 2 3 4 5 6 7 8 9 10 (very low)

(22)I would currently rate my headaches/migraines as:
(Very high) 1 2 3 4 5 6 7 8 9 10 (very low)

(23) I would rate my dependence on technology as:
(Very high) 1 2 3 4 5 6 7 8 9 10 (very low)

<u>PART II-Nordic Musculoskeletal Questionnaire</u>

(24) Do you experience problems in your neck after using the computer/laptop/cell phone?
(0)Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

(25) Do you experience problems in your shoulders after using the computer/laptop/cell phone?
(0) Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

(26) Do you experience problems in your upper back after using the computer/laptop/cell phone?

(0)Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

(27) Do you experience problems in your wrist/hands after using the computer/laptop/cell phone?
(0)Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

(28) Do you experience problems in your lower back after using the computer/laptop/cell phone?
(0)Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

<u>PART III-SF-12 Questionnaire</u>

(29) In general, would you say your health is:
(0) Poor (1) Fair (2) Good (3) Very Good (4) Excellent

<u>The following item(s) are about activities that you might do during a typical day.</u>

(30) Does your computer/laptop/cell phone use interfere with course/school work?
(0) A lot (1) a little (2) Not at all

(31) Does your computer/laptop/cell phone use results in discomfort in your neck/shoulder/hand/wrist?
(0) A lot (1) a little (2) Not at all

(32) Does your computer/laptop/cell phone use leave you feeling exhausted (having less energy)?
(0) A lot (1) a little (2) Not at all

(33) Does your computer/laptop/cell phone use leave you with little or no time for social activities (visiting friends, relatives, etc.)?
(0) A lot (1) a little (2) Not at all

<u>Part-IV The Internet Addiction Questionnaire (IAT)</u>

(34) How often do you find that you stay online longer than you intended?
(0) Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

(35) How often does your schoolwork suffer because of the amount of time you spend online?

(0) Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

(36) How often do you check your e-mail before something you need to do?
(0) Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

(37) How often do you lose sleep due to being online?
(0) Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

(38) How often do you choose to spend more time online over going out with others?
(0) Not applicable (1) Rarely (2) Occasionally (3) Frequently (4) Often (5) Always

APPENDIX D

Letter of Invitation to Potential Participates

RESEARCH TITLE: HEALTH EFFECTS ASSOCIATED WITH THE USE AND EXPOSURE TO ELECTRONIC OR DIGITIAL DEVICES AND TECHNOLOGIES WITH A VIDEO DISPLAY TERMINAL ON UNIVERSITY STUDENTS IN THE DURHAM REGION OF ONTARIO, CANADA: A DOSE-RESPONSE STUDY

Hello,

My name is Altaf Ghori and I would like to cordially invite you to participate in a research study entitled *The negative health effects of exposure to video display terminals by university students in the Durham Region of Ontario, Canada: A dose-response study*. This study is being completed as part of my Master's Degree in Health Sciences at the University Of Ontario Institute Of Technology (UOIT).

The aim of this study is to analyze the potential negative health effects associated with use and/or exposure to electronic or digital devices and technologies with a video display terminal (VDTs) (e.g., laptops, cell phones, tablets, iPods, desktop computers, etc.) by undergraduate university students. Student participation will help to gauge the dose-related or time dependent effects of exposure to electronic devices having video display terminals (VDTs). It is hoped that this research study will provide important preliminary insights into the potential negative health effects associated with both long-term and short-term exposures to video display terminals in the near future.

If you have any questions as to your rights while participating in this study, please contact the University of Ontario Research Ethics Committee, Research Administration/Compliance Officer at compliance@uoit.ca or (905) 721-8668 ext. 3693

If you have any questions, please do not hesitate to contact me at (416) 988-1625 or e-mail me at altaf.ghori@uoit.ca

Thank you.

Altaf Ghori
(M.HSc. Candidate)
Faculty of Health Sciences
UOIT
altaf.ghori@uoit.ca
Phone: 416-988-1625

Faculty Supervisor
Dr. Wally Bartfay, RN,PhD
Associate Professor
Faculty of Health Sciences
UOIT
wally.bartfay@uoit.ca
Phone:905-721-8663 X2765
Fax: 905-721-3189

Thank-you for participating in this research study!

APPENDIX E

Consent Form

RESEARCH TITLE: HEALTH EFFECTS ASSOCIATED WITH THE USE AND EXPOSURE TO ELECTRONIC OR DIGITIAL DEVICES AND TECHNOLOGIES WITH A VIDEO DISPLAY TERMINAL ON UNIVERSITY STUDENTS IN THE DURHAM REGION OF ONTARIO, CANADA: A DOSE-RESPONSE STUDY

You have been invited to take part in a study being conducted by Altaf Ghori (M.HSc. Candidate) and Dr. Wally Bartfay from the Faculty of Health Sciences at the University Of Ontario Institute Of Technology (UOIT). This study is being conducted in partial fulfillment of the Masters of Health Sciences degree by Mr. Ghori, and is being supervised by Dr. Wally J. Bartfay. This study has been reviewed by the Research Ethics Committee and received clearance through the Research Ethics Board (REB) on the following date ___________ (REB file # _____________).

Aim of the study

The purpose of this study is to analyze the potential negative health effects associated with the use and/or exposure to electronic or digital devices and technologies with a video display terminal (VDTs) (e.g., laptops, cell phones, tablets, iPods, desktop computers, etc.) by undergraduate university students.

Procedures

If you wish to participate in this study, you will be asked to complete a short paper and pencil-type of questionnaire. This questionnaire consists of questions about yourself, your program and year of study, health-related questions, some questions about how you feeling, behaviours and attitudes when using a variety of electronic or digital devices. This questionnaire will take about 8-10 minutes to complete. All questionnaires will be coded and your name or student number will not appear on the questionnaire to ensure your confidentiality. You may choose to complete this survey online (electronically via surveymonkey.com) or if you wish, a hard-copy can be provided

Potential discomfort and risks

We anticipate that there will be no discomfort or pain experienced when answering the questions. You also have the right to refuse to answer any questions that you may not feel at ease answering, deem as inappropriate, and/or makes you feel uncomfortable.

Potential benefits

Completing this survey may help identify potential negative health effects associated with use and/or exposure to electronic or digital devices and technologies by students. This study may also help to identify certain primary prevention and/ or health promotion activities that may avert any negative health conditions or states associated with the use of these devices and technologies. If you choose to participate in this study, your name will be entered into a random draw consisting of 2 gift certificates worth $25 each of your choice.

Confidentiality

Your responses and identifiers and everything that is connected with you within the study will be strictly confidential and will be available only after your consent. The survey that is returned will be kept under lock and key for a period of 5 years in a locked steel metal filing cabinet and then destroyed. Only the graduate student and supervisor will have access to them.

Participation/Withdrawal

Participating in this study is entirely and freely up to you. If you choose to participate in this study you have full right to withdraw at any time without any consequence or noted penalties.. Your name will not appear on any questionnaires, documents, reports and/ or publications, and all data collected (i.e., questionnaire) will be coded and the data will be presented as overall group findings only.

Your rights

You may freely choose to consent to partake in this study or not without any noted privileges or reimbursements (e.g., monetary) for agreeing to partake. You name and/or student number will not appear in any data sets or any peer-reviewed publications, reports or conference proceedings that may arise from the analysis of the data, and only group (aggregate) findings will be presented and/or published. You also have the right to withdraw your consent at any time without any noted consequences or penalties towards your coursework, grades, academic standing and/ or any other services received or rendered at UOIT. If you have any questions regarding your rights, please contact the University of Ontario Research Ethics Committee, Research Administration /Compliance Officer at compliance@uoit.ca or (905) 721-8668 ext. 3693. In addition, if you have any questions, doubts or concerns about this study, please feel free to contact myself Altaf Ghori at altaf.ghori@uoit.ca (Phone: 416-988-1625) and/or my supervisor Dr. Wally Bartfay at wally.bartfay@uoit.ca. (Phone: 905-721-8668 ext. 2765).

Thank-you!

Sincerely yours,

Altaf Ghori, B.A.Sc.
(M.HSc. Candidate)
Faculty of Health Sciences
University of Ontario Institute of Technology (UOIT)
altaf.ghori@uoit.ca Phone: 416-988-1625

Dr. Wally B artfay
Associate Professor
Faculty of Health Sciences
UOIT
wally.bartfay@uoit.ca
Phone: 905-721-8663 ext. 2765
Fax: 905-721-3189

Consent

I consent to partake in this investigation being conducted by Altaf Ghori and supervised by Dr. Wally J. Bartfay.

Name (PRINT): ____________________

Signature: __________________________ Date:_______________

Please enter the information for the random draw of $25 gift certificates

Email address: ____________________

Program: __________________________

Year: ____________________________

APPENDIX F

Study Design and Methods

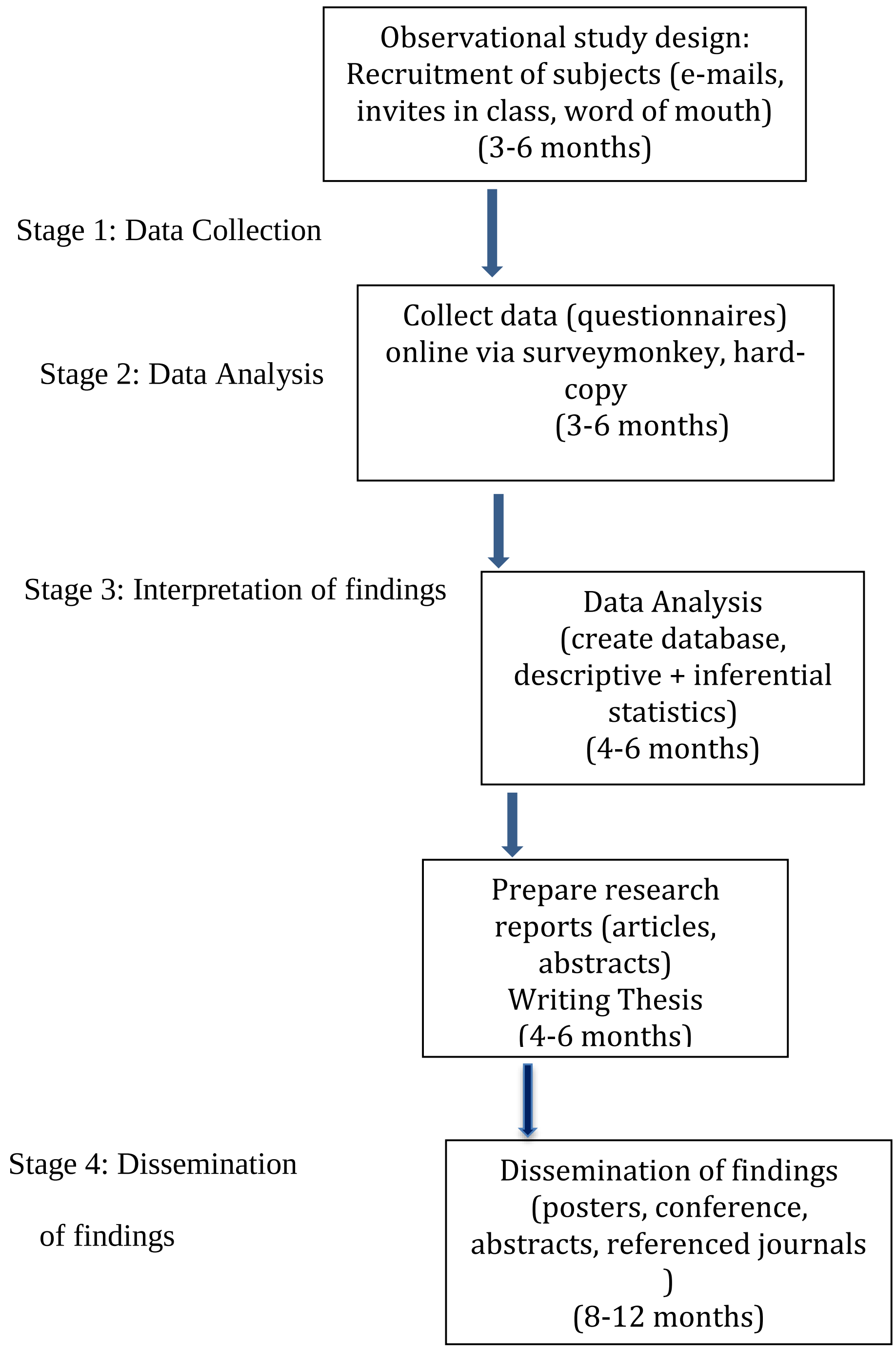

Figure 2: Flow chart summarizing methods that will be used in this study

APPENDIX G

Glossary of key terms

Body Mass Index: It is a ratio of the height and weight of a person and provides a good indication of the fatness of the body.

Carpal Tunnel Syndrome: Carpal tunnel syndrome is defined as a nerve entrapment syndrome of the median nerve at the wrist leading to numbness, loss of sensation and sometimes wasting of the areas supplied by the median nerve.

Cathode ray tube (CRT): Is defined as a medium usually aspecialized vacuum tube upon which an image is produced when an electron beam strikes a phorporescent surface.

Cervical Spondylosis: Defined here as a degenerative arthritis of the cervical spine.

Ergonomics: Science dealing with a specific design in order to reduce fatigue or any type of discomfort usually in the workplace, to maximize efficiency.

GHQ-12: It is a 12 item questionnaire designed by Goldberg and Williams (1988) that has been extensively validated and used in many countries and focuses on inability to carry out normal functions and the occurrence of distressing symptoms.

Glioma: Any cancer that is derived from specific types of cells in the brain, spinal cord, pineal gland, posterior pituitary gland or retina.

Impulsive control disorder: A disorder characterized by failure to restrain oneself from behaviours that maybe harmful to self or to others.

Internet addiction disorder (IAD): Internet Addiction Disorder (IAD) is here defined as excessive use of the computer such that it may hamper daily life.

Light Emitting Diode (LED): A light-emitting diode (LED) is a semiconductor device capable of emitting visible light upon passing an electric current.

Liquid crystal display (LCD): It is a type of technology that is used to display any type of information in smaller computers.

Median nerve neuropathy: Any damage to the median nerve. Refer to Carpal Tunnel Syndrome.

Meningioma: A benign tumor that arises from the meninges of the brain.

Millennials: Are here defined as individuals born between 1981-2000 who are university students who employ technologies (e.g., laptops) on a regular basis.

Radio frequency wave: It is defined as waves that are in the same frequency range as radio waves (about 3 kHz -300 GHz) as well as alternating currents which carry the radio signals.

Reliability: The extent to which a questionnaire will produce a similar result if re-administered to the same group if the conditions remain unchanged (Black, 2006).

Schwannomas: A benign tumor of the schwann cells responsible for the myelin sheath found in various nerves.

Somatization: Defined as a physical symptomatology from several organ systems that one experiences which has no medical explanation supporting it.

Validity: Refers to whether or not a specific questionnaire measures what it is intended to measure and assess specific constructs

Video display terminal (VDT): Is a term used to describe a visual electronic and/or computer display.

Visual Analogue Scale (VAS): A scale that measures intensity of a particular variable (e.g. pain) according to the participants own subjective feelings

APPENDIX H

REB APPROVAL LETTER

Date: September 23rd, 2013

To: Altaf Ghori (PI), Wally Bartfay

(Supervisor) From: Bill Goodman,

REB Chair

REB File #: 12-120

Project Title: Health effects associated with the use and exposure to digital or electronic devises and technologies with a video display terminal on university students DECISION: APPROVED

START DATE: September 23rd, 2013 EXPIRY: September 23rd, 2014

The University of Ontario, Institute of Technology Research Ethics Board (REB) has reviewed and approved the above research proposal. This application has been reviewed to ensure compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2) and the UOIT Research Ethics Policy and Procedures.

Please note that the (REB) requires that you adhere to the protocol as last reviewed and approved by the REB.

Always quote your REB file number on all future correspondence.

Please familiarize yourself with the following forms as they may become of use to you.

- **Change Request Form:** any changes or modifications (i.e. adding a Co-PI or a change in methodology) must be approved by the REB through the completion of a change request form before implemented.
- **Adverse or unexpected Events Form:** events must be reported to the REB within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol. (I.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).
- **Research Project Completion Form:** must be completed when the research study has completed.
- **Renewal Request Form:** any project that exceeds the original approval period must receive approval by the REB through the completion of a Renewal Request Form before the expiry date has passed.

All Forms can be found at http://research.uoit.ca/faculty/policies-procedures-forms.php.

REB Chair
Dr. Bill Goodman, Faculty of Health Sciences bill.goodman@uoit.ca
Ethics and Compliance Officer compliance@uoit.ca

University of Ontario, Institute of Technology
2000 Simcoe Street North, Oshawa ON, L1H 7K4
PHONE: (905) 721-8668, ext. 3693

APPENDIX I

CURRICULUM VITAE

Curriculum Vitae
Altaf Ghori (B.A.Sc.)

B.A.Sc.
Public Health
Ryerson University
350 Victoria Street
Toronto, ON
M5B 2K3

Contact
305-3950 Lawrence Ave. E.
Toronto, ON, M1G1R8
Phone: (416)988-1625
Email:ghori.altaf@gmail.com

Objective

Seeking a suitable position in Healthcare.

Summary of Qualifications

Results oriented, resourceful professional with extensive experience in the healthcare environment. Experienced in the healthcare field with a focus on Pharmaceutical Industry; also experienced as a physician in the family medicine department focusing on outpatient areas. Experienced in screening phase and the study phase of Phase I and Phase III clinical trials with a focus on obtaining informed consent, phlebotomy, data entry in live EDC (Medidata Rave), customer service, Anthropometric measurements, shipment of samples, dispensing of medications, coordinating with senior site coordinator, principle investigator and study monitor; monitoring volunteers, ensuring the smooth running of study and compliance of study protocol.

Major strengths include strong communication skills-both oral and written, attention to detail, team player, dutiful respect for compliance in all regulated environments. Thorough knowledge of searching databases for current evidenced based research and drafting proposal for Ethics Board and Grant Applications gained through thesis-based Masters in Health Sciences program; proven ability to maintain, track and review and assess clinical documents. Knowledge of MSOffice series and internet usage.

Education

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY (UOIT), Oshawa, Ontario
Currently enrolled in the Masters of Health Sciences thesis based program at UOIT focusing on Community health. Courses include Research in Health Sciences, Studies in Community Health, Applied Statistics in Health Sciences.

RYERSON UNIVERSITY, Toronto, Canada
Graduated from *Public Health (B.A.Sc.)* program of the School of Occupational and Public Health. Courses include Health Promotion: Planning and Evaluation, Health Administration, Health Education, Food Pathogens, Public Health Law, Risk Assessment, Hazard Recognition and Control, Emergency Measures and Planning, Biostatistics, Epidemiology Research Methods.

Courses taken and description: Epidemiology Research Methods study of research and investigation, the design of studies, and methods used to control for selection bias Survey research, from sample size determination have also been explored in this course, **Biostatistics** the normal distribution, random sampling, univariate values, t-tests, chi-square, Fisher's exact, three ANOVA models, simple regression and correlation, **Risk Assessment** application of risk analysis, methods for estimating risks, risk identification, pathways analysis, exposure models and dose-response relationships, the process of risk perceptional and communication **International Health** theories and practices of environmental health, emphasis on cross cultural and international health work and epidemiology **Health Promotion: Planning and Evaluation** Health promotion theory and principles. Local and international frameworks, issues and strategies related to health promotion. Opportunities to complete a community analysis, to develop a proposal for a comprehensive program for a selected community, and to critically analyze other health promotion programs **Health Education** the determinants of health, adult learning styles, theories related to individual, group and community behavior models are explored and analyzed. **Other courses include Food Pathogens, Public Health Law, Emergency Measures and Planning, Health Administration**

JJM MEDICAL COLLEGE, India
Awarded the *Bachelor of Medicine and Bachelor of Surgery (M.B.B.S.) degree* from a WHO recognized Institute in India. Courses taken include Anatomy, Physiology, Biochemistry, Pathology, Microbiology, Pharmacology, **Preventive and Social Medicine (equivalent to Public Health),** Surgery, Medicine, Orthopedics, Obstetrics and Gynecology, ENT, Ophthalmology.
Graduated July 2001

Publication(s)

Gary, L., Mroziewicz, M., **Ghori, A.**(August, 2010). Cancer: Health Effect of Air and Water Pollution. http://www.ecopolitics.ca/airpol/cancer_air_water_pol.php

Academic Achievements

Medical Council of Canada Evaluating Examination (MCCEE)
Ontario Society of Medical Technicians/Technologists (OSMT)

Professional Affiliations

Student Member of the Canadian Institute of Public Health Inspectors (CIPHI)

Volunteer Activities

2010-Present (Part time) Volunteering as a Research Assistant for **Ecopolitics,** a company dedicated to improving the Environment and thereby the health of the public at large. Responsibilities include Researching Peer Reviewed Journals, Contacting Professors in the field of Public Health to discuss issues related to environment, Summarizing various peer reviewed articles.

2011- Present (Part time) Participating in the planning, implementation, promotion and evaluation of Islamic Online University, helping in the scheduling of volunteers needed to promote the Islamic Online University, distributing promotional material

Work Experience

Kids Clinic, Whitby, ON April 2013-June 2013
Site Coordinator

- Maintained and individually managed study binders, regulatory binders and health

Databases (EDC systems like Medidata Rave)

- Maintained communication with monitors and PIs regarding protocol deviations
- Interviewed patients participating in the study and obtained informed consent
- Ensured that inclusion/exclusion criteria are adhered to
- Screened participants to participate in study
- Performed ECGs and Anthropometric measurements
- Delegated responsibilities and trained new employees
- Supervised employees and guided the course of the study
- Ensured proper storage, dispensation/return of study medication
- Prepared and shipped biological samples
- Prepared slides and centrifuged samples according to protocol requirements

Anapharm Inc. **2007-2009**
Worked as a Assistant Team Lead (Screening)
Major Responsibilities include

- Involved in Screening volunteers coming for study
- Led a team of technicians in the Screening Department
- Awarded the company appreciation medal for knowledge of Standard Operating Procedures and application thereof
- Responsible for presentations to the public on various drugs and side effects and other public health related issues
- Trained staff on safe handling of human specimens
- Adhered to ICH/GCP guidelines
- Data Entry and Documentation of volunteer profiles
- Completed CRFs and submitted to higher authorities
- Performed ECGs, Anthropometric measurements
- Obtained consent from volunteers to participate in studies conducted at Anapharm

Kriger Research Institute **2007-2008**
Worked as a Clinical Research Associate (Part time basis)

- Worked on 3 different projects for Kriger Research
- Involved in Pre-Study Visits
- Conducted Site Evaluation, Site Initiation,
- Monitoring on-site and training of personnel

Public Health Experience

JJM Medical College Have experience as a *Medical Intern* in the Public Health department where my responsibilities included:

- Educating the general public on consumption of safe food and potable water
- Advising the public on issues like using bednets to prevent malaria, building proper roofs on top of their houses, proper nutrition for children
- Emphasized breast feeding for infants and advised people against rural infant feeding practices
- Advising mothers-to-be on issues of good nutrition and general healthcare including regular antenatal visits to our clinic
- Focusing on educating the rural population about vaccinations, regular visits to the healthcare professionals
- Conducting clinical examinations on adults and children alike to assess their medical conditions and prescribing a treatment regimen for different types of medical conditions
- Organizing and participating in educational campaigns and measures as part of a WHO vaccination program

Access Alliance Multicultural Health Centre Have experience working as part of a Public Health Emergency Response as a *Frontline SARS worker* during the SARS outbreak where my responsibilities were:

- Advising the public to wash hands properly and regularly and not to come into contact with people who they may suspect as having a cold or fever
- Working in the frontlines checking vital signs like temperature, Blood Pressure etc. of patients coming into doctors' offices
- Distribution of literature to educate the public on SARS and how to recognize symptoms and signs
- Helping newcomers to Canada by interpretation and translation from native languages like Urdu, Hindi to English
- Watching for signs of illness resembling cold as directed by physicians

Languages

English- Speak, write and read-Advanced level
Hindi-can read, speak at a conversational level
Urdu- can speak at a conversational level
Bengali-basic understanding
Tamil-basic understanding
Arabic-can read, write at a very basic level