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Video Display Unit Exposure and Risk of Musculoskeletal Symptoms During Covid-19 Pandemic

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Abstract

The number of visual display unit (VDU) users is growing dramatically. The VDU use during open and distance learning (ODL) frequently forces the users to adopt a repetitive motion, and static and sustained postures leading to an increased risk of musculokseletal symptoms (MSS). The study aimed to assess the ergonomic risk factors (ERFs) on MSS when working with VDU among undergraduate students in USM Health Campus (USMKK). A cross-sectional study was conducted among 385 undergraduate students in USMKK. A modified and adapted questionnaire was used to assess the demographic, VDU risk factors and Nordic Musculoskeletal Questionnaire. The data were analyzed using descriptive and inferential statistics; Chi-Square and Logistic Regression tests. The highest six-month prevalence of MSS was neck (75.7%). Chi-Square test revealed that the six months prevalence of MSS on body regions that have significantly associated with gender are shoulder, upper back, lower back, and knees ($p<0.05$). Duration of exposure to VDU screen for more than 6 hours/day for ODL increased the risk of shoulder [Odd Ratio (OR) and 95% Confidence Interval (CI): 4.34(1.71-10.99)], upper back [OR(95% CI): 3.34(1.33-8.37)] and lower back pain [OR(95% CI): 4.19(1.68-10.42)]. Exposure to VDU for 4-6 hours/day was also associated with shoulder and lower back pain. Chair, desk and accessories factor increased the risk of shoulder, elbow, wrists/hands, upper back, hips/thigh and knees pain. The results of this study indicated that ERFs when working with VDUs were associated with the chronic MSS. These association patterns also suggest opportunities for intervention strategies in order to stimulate an ergonomic workplace setting.

Keywords: Musculoskeletal Symptoms, Musculoskeletal Disorder, Ergonomic, Video Display Unit, Online Learning, Open and Distance Learning

Introduction

The purpose of ergonomics is to adapt tasks, working conditions, work methods, tools, and machines to maximise the suitability for people (Loo & Richardson, 2012). Ergonomics is concerned with computer equipment such as the physical design of the keyboard, screens, and related hardware, and how people interact with these hardware devices (Howe, 2010). Ergonomics plays a vital role in makes sure capacity and capability well-performed. When users understand and learn about ergonomics, it helps to make strides in the working environment. Thus, people can work in a way that gives comfort and use the minimum amount of energy efficiently (Muin & Sapri, 2013). In the technological revolution, the computer's usage with screen-based output units or visual display units (VDUs) grows increasingly. The VDUs are in use worldwide for receiving and processing information on television-like screens or monitors. Sitting in front of the computer for a long time can cause fatigue, inflammation of the lower limbs, low back pain, and headache, as well as an improper chair position and height, which can cause acute disorders (Canadian Centre for Occupational Health and Safety, 2021).

Ergonomic risk factors may lead to the development of musculoskeletal disorders (MSDs) and can affect muscles, ligaments, joints, and other body regions. Ergonomics includes three main domains which are physical, cognitive, and organisational. The human body's responses to physical and physiological work demand are known as physical ergonomics. The objective of the Occupational Safety and Health Act 1994 (OSHA 1994) related to physical ergonomics is to promote an occupational environment for the person at work which adapted to their physiological and psychological needs (Department of Occupational Safety and Health (DOSH), 2017). Individual exposed to ergonomic risk factors such as repetitive or sustained awkward posture, forceful exertions, and high task repetition have a higher chance to get MSDs (Middlesworth, 2015). The ergonomic risk among students may increase due to the recent COVID-19 outbreak (Dhawan, 2020).

COVID-19 pandemic has resulted in schools being closed worldwide. As a result, education has changed dramatically, with the e-learning enhancement, in which teaching is done remotely and on digital platforms (Li & Lalani, 2020). Dhawan also stated that this situation challenges the worldwide education system and forcing educators to switch to online teaching mode. Since the pandemic, most of the students spend more time on digital devices during virtual learning (Balram, 2020). The number of institutions that implemented computer requirements has been rising. This potentially increased the exposure of students to computers. Laptop or tablets personal computers (PCs) are the most often required and impose the ergonomic risk (Noack-Cooper et al., 2009). Students started to use computers earlier than office workers and continue to surpass the typical office worker usage (Laeser et al., 1998). According to Noack-Cooper, Sommerich, & Mirka, computer usage indicated that college students are exposed to some of the risk factors that may cause the risk of musculoskeletal disorders to increase.

Literature Review

DOSH (2003) defined the Visual Display Units (VDUs) is any alphanumeric or graphic display screen, regardless of the display process employed. The term VDU is frequently used synonymously with the monitor. Despite that, it can also refer to other types of display like a digital projector (Christensson, 2009). The roles of technology in education have directly and indirectly changed the design and delivery of the teaching and learning process (Kirkwood & Price, 2014). Personal computers such as laptops, desktops, notebooks, and tablets are starting to replace conventional classroom teaching and learning system (Van der Kleij et al., 2015; Castillo-Manzano et al., 2017). Dockrell et al (2015) stated that it is a must for college and university students to have a personal computer either for personal use, social use, or for academic purposes. The use of personal computers by students increased and resulted in a variety of computer-related health disorders.

The pandemic COVID-19 crisis factors have changed the landscape of the system of education from conventional teaching and learning activities to open and distance learning (ODL). ODL is seen as an alternative method in higher education settings in Malaysia. Teaching processes using ODL platforms like Whatsapp, Telegram, Google Meet, Hangout, Google Classroom, Ilearn, and Ufuture are used (Musa et al., 2020). According to Ghosh, Nath, Agarwal, Nath, & Chaudhuri (2012), the term Open and Distance Learning (ODL) is a reflection of the fact that all or most of the teachings are taught by someone (educator), who is far from the learner (students), and the goal aimed at providing dimensions of transparency and flexibility. The term ODL is also used interchangeably with terms such as e-learning (Keis, Grab, Schneider, & Ochsner, 2017), blended learning (Deschacht & Goeman, 2015), online learning (Wallace, 2010) and virtual learning with the main idea stated that activities of learning in an informal form, use any internet tools and little or no physical social interaction with the lecturer (Kuo et al., 2014). ODL can be conducted in a variety of ways such as video conferencing, synchronous and asynchronous, open online courses, hybrid distance education, computer-based, and fixed time online course.

According to Kenny (2010), most distance education fully utilizes the internet network and easy access for most students either through laptops or mobile phones (Hussin et al., 2017) in their own homes. In 2005, a study by Hamilton, Jacobs & Orsmond reported that 82% of students spend up to 6 hours per day on a computer, with almost 28% reported that they spend 4 to 6 hours per day computing. Meanwhile, Menendez et al. (2008) found that 17% of students estimated they used a computer daily for 6 to 8 hours. Since this COVID-19 pandemic, it may be intuitive to link digital device usage to the increased time spent indoors and near work (Wai et al., 2020), thus conferring an increased risk of musculoskeletal. DOSH (2017) stated that minimal or limited or no movement where the body held on to a certain position for a long time is referred to as static or sustained posture. Maintaining a fixed posture can cause fatigue, pain, and injuries that cause a variety of disorders. The most common examples are prolonged standing and sitting. Prolonged standing refers to any work activity that involves standing for more than 2 hours. Meanwhile, any work activity involving a sitting position for more than 30 minutes is known as prolonged sitting. However, the duration is subjective and may vary depending on the assessment of the trained person.

Sitting in front of the computer for a long time can cause fatigue, inflammation of the lower limbs, low back pain, and headache, as well as an improper chair position and height, which can cause acute disorders (Canadian Centre for Occupational Health and Safety, 2017). When the posture deviates more than neutral, the muscles are responsible for the preferred rotating or bending side becomes stronger and the corresponding antagonistic muscles become elongated and weaken, creating a muscle imbalance (Valachi, 2003). Repetitive motion involves repeated movements from similar groups of joints and muscles too often, too quickly, and over a long time. The time cycle that considers very repetitive in jobs is 30 seconds or less (DOSH, 2017). When an action is performed repeatedly, repetitive motion injuries occur. Pain or other warning signs may arise gradually over time or may be acute in extreme conditions. Many areas can be affected by repetitive motion action. The most affected are the fingers, hands, wrists, elbows, arms, shoulders, back, and neck (Jepsen & Suchy, 2015). DOSH stated that tasks with repetitive movements frequently involve other risk factors like fixed body position and force. Frequently repeated motions and prolonged periods can result in accumulated muscle-tendon strain and fatigue. The muscles and tendons can recover from vigorous exertions and stretching effects if the time allocated between the exertions is enough. The impact of repetitive motions increases because doing the same work activities during inappropriate postures and vigorous exertions performed. Risk factors like repetitive actions can also depend on the performed specific actions and the area of the body (Korhan & Memon, 2019).

According to Moras & Gamarra (2007), students used the laptop not only for studying though also for entertainment, communication, and other activities. The study conducted by Agnes & Saliza (2016) found the students who experienced musculoskeletal symptoms (MSS) in at least one part of the body were 67%. The most common musculoskeletal symptoms were shoulder pain (46.2%), neck pain (41.1%), upper back pain (39.1%), and lower back pain (34.5%). Khan et al. (2012) discovered that only 52.3% of the respondent has heard and knowledge about ergonomic. These showed that the study of ergonomic when working with visual display units needs to be done. The reason is, the knowledge and application of ergonomics are required to prevent the onset and progress of musculoskeletal injuries as well as improve one's health status (Wahlstro et al., 2000). There are few studies that have assessed the association between laptop computer usage and musculoskeletal symptoms among college students (Hamilton et al., 2005; Jacobs et al., 2009; Raps & Nanthavanij, 2008; Shin, 2010; Rajagopal et al., 2012). Meanwhile, Chavda et al (2014) also suggested that researches are needed to evaluate the relationship between the practice of laptop computer and musculoskeletal health problems.

Computers usage is an inherent part of people's everyday lives, and students are no exception (Kobus et al., 2013). However, female students were more likely to report computer-related musculoskeletal symptoms (MSS) than male students. Students often have more written assignments and the completion of these assignments may have required longer continuous computer usage especially during this pandemic situation (Dockrell et al., 2015). Therefore, these causes students to sit on the chair longer time. In a study by Araújo et al. (2020), an association between altered lower limbs in the sitting position and anterior head detection for females was observed and found that longer time may increase the chance of adopting an inappropriate sitting posture. Antonelli et al (2020) observed that low back pain was more frequent in Physiotherapy than in Medicine students, but there was no difference in the intensity of pain and disability, and no increase in lumbar pain during the undergraduate course. Some activities practiced by students in different academic courses may be considered risk factors for the development of back pain such as manual therapy and transfer of dependent patients. Therefore, this study will assess ergonomic risk factors when using VDUs and MSS experienced by the students.

Methodology

This cross-sectional study was conducted in USMKK, Kubang Kerian, Kelantan. Ethical approval had been obtained from Human Research Ethics Committee, USM on March 2021 (USM/JEPeM/21010101) before conducting the research. A response rate of 93% was obtained with 358 undergraduate students from three schools in USMKK were participated in this study through stratified and random sampling. Students who were using VDU for ODL inside and outside campus were included in the study. Study was conducted from October 2020 to August 2021. Questionnaire used in this study were adapted from Teen Nordic Musculoskeletal Screening Questionnaire (TNMQ-S) (Descarreaux et al., 2014), Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka et al., 1987), and questionnaire on VDU work (Kerckebosch, 2014). Section A consists of several questions about demographic information such as gender, age and school, social/lifestyle, and medical history. There are six (6) questions in section B for visual display units on work which include an hour and frequency using the VDU screen during ODL, condition of VDU screen, keyboard and mouse, chair, desk, and accessories, working and resting hours, sitting posture, working technique, and home situation. The scoring for section B, from question 2 to question 6 were scored on two score point's scale which is 0 and 1. The score was then classified into low risk (0-1), medium risk (2-4), and high risk (5 and above). The last section is the musculoskeletal symptoms for body regions. Three questions were asked for each nine body region. These include the presence of ache, pain, discomfort or numbness at each body region in the last six months and seven days (NMQ), and the impact on sport/leisure activities (TNMQ-S). The nine body regions are neck, shoulder, elbows, wrist/hands, upper back, lower back, hips/thigh, knees, and ankles/feet. The TNMQ-S seems to be a suitable tool to be used in the adolescent population as a self-administered online musculoskeletal disorder screening tool. Previous studies by Descarreaux, Legault & Cantin have shown that a longer recall period (12 months) tends to cause recall bias about injuries, especially if the injuries are less severe. The recall period chosen was six months. This is because the 12-month recall period is often influenced by memory decay, and minor injuries are more likely to be forgotten.

The questionnaire was piloted among 40 students from the same campus to check the reliability and validity of the questionnaire prepared. The questionnaire was reliable and valid as the Cronbach alpha value obtained was 0.71. The study invitation, consent form and self-administered online questionnaire were sent to the respondents through email and WhatsApp. Statistical Package for Social Sciences Software (SPPS) version 24 was used to analyse the data. Descriptive statistics were used to summarise the socio-demographic characteristics of the respondents, VDU exposures, ergonomic risks, and presence of musculoskeletal symptoms. Numerical data was presented as mean (SD) based on their normality distribution. Categorical data was presented as frequency (percentage). Logistic regression was used to explore the association between ergonomic risk factors and MSS when working with VDUs.

Results and Discussion

Demographic Information

Table 1 shows the frequency and percentage for demographic of the respondents. Among the respondents, the vast majority were females 71.8% and 66.8% aged 19-22 years old. The individual response rates by school were as follows; PPSK (58.4%), PPSG (14.5%) and PPSP (27.1%). As PPSK consists of 10 programme, audiology, biomedicine, dietetics, environmental and occupational health, exercise and sport science, forensic science, medical radiation, nursing, nutrition and speech pathology, thus the percentage of respondents from PPSK is higher than PPSG and PPSP. Only 0.6% of the respondents were smoking. Smoking prevalence among health care students (16.8%) was low in Morrell et al (2008) study. In addition, healthcare students showed greater knowledge regarding tobacco-related health risk. Surfing internet (50.0%) was the most preferred hobby by respondents while the least one was hunting (0.3%). A study conducted by Apuke and Iyendo (2018) stated that more than half of the students (62%) claimed to use the internet on a daily basis, follow by 18% who use it 2 to 5 times a week, 9.65% use it one in a week, while 10.4% maintained a neutral response. Respondents who have illness were 10.3% and 8.1% taking medication. The most common illness was asthma (2.8%) which is consistent with the findings from Gazibara et al (2018) who reported that asthma (4.2%) and chronic bronchitis (3.1%) were amongst the common diseases.

Table 1
Demographic distribution of the respondents (N=358)

Demographic Variables	n (%)
Gender	
Male	101 (28.2)
Female	257 (71.8)
Age	
19-22	239 (66.8)
23-26	111 (31.0)
≥27	8 (2.2)
School	
School of Health Sciences (PPSK)	209 (58.4)
School of Dental Sciences (PPSG)	52 (14.5)
School of Medical Sciences (PPSP)	97 (27.1)
Social/Lifestyle	
Smoking:	
Yes	2 (0.6)
No	356 (99.4)
Hobby/Leisure activities	
Hunting, fishing	3 (0.9)
Sports	85 (23.7)
Gardening	15 (4.2)
Surfing Internet	179 (50.0)

Others	76 (21.2)
Medical history	
Do you have any illness confirmed by a doctor?	
Yes	37 (10.3)
No	321 (89.7)
Do you take any medication?	
Yes	29 (8.1)
No	329 (91.9)

VDU Risk Assessment during ODL
Table 2 shows the summarized score results for VDUs exposure of the respondents. In VDU screen, keyboard and mouse factor, the percentage of risk is increasing from low to high as well as chair, desk, and accessories and sitting posture and working technique. VDU screen, keyboard and mouse reported the higher risk (77.4%) compared to others. This result goes along with the report conducted by EU-OSHA (2013) analysed which repetitive hand and wrist movement, hands and finger in repetitive movements with short cycles may cause to an increase of MSD complaint. Also, EU-OSHA stated that equipment and workstation such as screen, keyboard and mouse used can pose a risk when the use of keyboard requires the depression on the keys, screen is placed too high or low in relation to users and repetitive clicking of the mouse. In addition, the factor of chair, desk and accessories. The study conducted by Dinar et al (2018) among office workers found that if the VDUs user's seat size is not appropriate, the body mass will not be effectively distributed, resulting in an awkward position. The result of Dinar et al. also showed that there is relationship between work posture and appropriate table.

The risk level of working hours and (micro) breaks and home situation recorded at medium level as higher percentage which are 76.0% and 90.2%, respectively. The study conducted by Larrea-Araujo et al (2021) found that VDU users spends 4 hours per day or 20 hours per week with the VDU. This is influenced some health consequences due to intensive use of VDU. These conditions are related to ergonomic risk factors. Furthermore, in this study, sitting posture and working technique recorded the highest percentage for high risk. As work with a VDU is primarily performed in a sedentary posture, musculoskeletal disorders may occur. This is also influenced by the workstation design, and the repetitive movements of hands, wrists, and fingers (National Institute of Occupational Safety and Hygiene, 2020). Lopez & Franco (2019) stated that due to the wrong postures, the musculoskeletal stress can be prolonged, maintained, or forced. The workstation design considers the furniture, chairs, desks, screens, keyboards, or peripherals that are not properly placed, which may contribute to users using improper postures. Result in this study stated that at home situation for VDUs factor also found the highest level in medium risk which is 90.2% and 9.8% for low risk.

Table 2
Risk scores of VDUs exposures (N=358)

Variables	Level of Risk	n (%)
VDU screen, keyboard, and mouse	Low Risk (0-1)	2 (0.6)
	Medium Risk (2-4)	79 (22.1)
	High Risk (5-9)	277 (77.4)
Chair, desk, and accessories	Low Risk (0-1)	35 (9.8)
	Medium Risk (2-4)	88 (24.6)
	High Risk (5-10)	235 (65.6)
Working hours and (micro) breaks	Low Risk (0-1)	26 (7.3)
	Medium Risk (2-4)	272 (76.0)
	High Risk (5)	60 (16.8)
Sitting posture and working technique	Low Risk (0-1)	4 (1.1)
	Medium Risk (2-4)	96 (26.8)
	High Risk (5-9)	258 (72.1)
The home situation	Low Risk (0-1)	35 (9.8)
	Medium Risk (2-4)	323 (90.2)

Prevalence of MSS

Table 3 shows the frequency and percentage of respondents who experienced MSS at nine body regions at any time during the last 6 months. A total of 75.7% of the respondents reported neck pain in the last 6 months, followed by lower back (70.1%), shoulder (63.7%), upper back (52%) and wrists/hands (50.8%). The least of MSS presence was on elbows (13.1%). These findings are in agreement with the study conducted by Ranasinghe et al. (2011) that was done among 2500 computer workers in Sri Lanka and they found the prevalence of neck and shoulder complaints were the highest. The previous study by Chowdhury et al (2014) stated that neck complaints were detected in 57.4% of office workers with high workload computer use while shoulder complaints were representing 53.5%. Low back pain was the highest complaint (78.0%) among computer users (Elkhateeb et al., 2018). Chodhury et al (2014) study which was done among 100 computer office workers in Bangladesh had detected that 91.1% of computer users were complaining of low back pain which is considered as the highest MSS. Hobby of surfing internet might be contributed to the risk of MSS in which increase the duration of students spent using VDU. Hobby of surfing internet might be contributed to the risk of MSS in which increase the duration spent using VDU. Either way, it is reasonable to assume that period of deskwork, sitting in a chair and using VDU during ODL was no doubt contribute to upper body MSS among the undergraduate students. Long periods sitting in front of personal computer could be also related to MSS of shoulder, neck and back regions.

Table 3
MSS of body regions during the last 6 months (N=358)

Statement	**n (%)**	
	Yes	**No**
Have you at any time during the last 6 months had trouble (ache, pain, discomfort, numbness) in:		
Neck	271 (75.7)	87 (24.3)
Shoulder	228 (63.7)	130 (36.3)
Elbows	47 (13.1)	311 (86.9)
Wrist/Hands	182 (50.8)	176 (49.2)
Upper Back	186 (52.0)	172 (48.0)
Lower Back	251 (70.1)	107 (29.9)
One or Both Hips/Thigh	73 (20.4)	285 (79.6)
One or Both Knees	90 (25.1)	268 (74.9)
One or Both Ankles/Feet	91 (25.4)	267 (74.6)

Association between Gender and Presence of MSS
Table 4 shows the presence of MSS on nine body regions at any time during the last six months between male and female students. The body regions that have significantly associated with gender were shoulders, upper back, lower back and one or both knees. Majority of respondents reported that the higher percentage of MSS presence on all body regions are females. Nevertheless, females also reported as higher percentage that have not presence MSS at all body regions. A study conducted by Sillanpaa et al (2014) indicated statistically significantly higher prevalence of pain in the neck for women than for the men. The results indicated that in the studied population, they may have been a difference in occupational exposure among men and women. The same explanation may also be relevant in this study, however, females are known to report higher percentage presence of MSS in the neck region than males. It can be said that generally females have smaller body size and dimensions and lower physical capacities compared to males. Hence, for males and females who are performing the same physical task, female will have a higher workload (Vingård et al., 2000). Therefore, this could result in more reported symptoms in shoulder region from females. This study findings agrees with the previous study that found the lowest frequency of complaint was associated to elbow pains (12.0%) (Kazemi et al., 2019). The lowest prevalence of MSS affected men and women was the elbow with a percentage of 6.53% and 0%, respectively (Rahman & Ruhaidi, 2017). In the study conducted by Sillanpää et al. also found that the prevalence of pain in the wrists is higher in females than males.

During the last six months, the presence of MSS at upper back and lower back in females reported higher percentages. In the study conducted by Rahman and Ruhaidi showed the different prevalence of MSS on different body region between men (n=46) and women (n=16). For males, the highest symptom affected was the lower back with the percentage of 89.1%, followed by upper back (67.4%) while the highest symptom affected to females was the lower back (85.7%) and upper back (71.4%). These findings contradicted to this study, in which males have the highest percentage for lower back than females, however, females recorded the highest percentage of upper back compared to males. Also, this study result agrees with the results of the study conducted by Aghili et al (2012) using the Nordic questionnaire among sewing machine operators of a shoe manufacturing factor in Iran found the association between knee pains with gender was found to be significant. Moreover, statistical test result associated the emergence of MSS in different body region to certain individual factors. For instance, study by Kazemi et al. stated that the knees disorder are more prevalent in males than in women ($p<0.05$), associated pains vary with gender. In contrast, Kazemi et al. stated that their study found there was significantly associated between ankles and gender, which also consistent with the study conducted by Aghili et al.

Table 4
Presence of MSS on body regions during the last six months between gender (N=358)

Variables	Yes	No	χ^2(df)	p value
Neck				
Female	197 (72.7)	60 (69.0)	0.452 (1)	0.501
Male	74 (27.3)	27 (31.0)		
Shoulders				
Female	178 (78.1)	79 (60.8)	12.236 (1)	*<0.001
Male	50 (21.9)	51 (39.2)		
Elbows				
Female	38 (80.9)	219 (70.4)	2.194 (1)	0.139
Male	9 (19.1)	92 (29.6)		
Wrist/Hands				
Female	130 (71.4)	127 (72.2)	0.024 (1)	0.878
Male	52 (28.6)	49 (27.8)		
Upper Back				
Female	146 (78.5)	111 (64.5)	8.599 (1)	*0.003
Male	40 (21.5)	61 (35.5)		
Lower Back				
Female	192 (76.5)	65 (60.7)	9.184 (1)	*0.002
Male	59 (23.5)	42 (39.3)		
One/Both Hips/Thighs				
Female	54 (74.0)	203 (71.2)	0.216 (1)	0.642
Male	19 (26.0)	82 (28.8)		
One/Both Knees				
Female	72 (80.0)	185 (69.0)	4.003 (1)	*0.045
Male	18 (20.0)	83 (31.0)		
One/Both Ankles/Feet				
Female	71 (78.0)	186 (69.7)	2.342 (1)	0.126
Male	20 (22.0)	81 (30.3)		

*Significance level at $p<0.05$; Statistical test: Chi-Square Test

Association between VDU Risk Factors and Presence of MSS

For the last six months, all of the body regions except lower back were affected to MSS risk as shown in Table 5. For neck, shoulders, elbows, wrists/hands, upper back and one or both hips/thigh and knees, these body regions were affected by chair, desk and accessories. Chair, desk and accessories factor increased the MSS risk for shoulders (Odd Ratio (OR)=5.280, 95% Confidence Interval (CI)=2.077-13.419), elbows with a very wide CI (OR=11.685, 95% CI=1.338-102.074), upper back (High risk: OR=4.848, 95% CI=1.849-12.713), lower back (OR=4.186, 95% CI=1.682-10.419), hips/thigh (OR=5.692, 95% CI=1.157-28.006), and knees

(OR=3.831, 95% CI=1.104-13.296), but decreased risk for neck and wrist/hands. The duration of respondents use the VDU screen for online learning were four to six hours and more than six hours in which increased the pain on shoulders (4-6 hours: OR=3.369, 95% CI=1.322-8.590; >6 hours: OR=4.335, 95% CI=1.711-10.987) and lower back, whereas respondents who spent more than six hours using VDU screen during ODL raised the risk of pain on upper back (OR=3.337, 95% CI=1.330-8.372).

These findings were similar to the study conducted by Celik et al (2018), who detected that the most harmful effects for MSS on body regions were sitting at the desk for a long time without a break, sitting on a chair that supported only the arms, and working holding both forearms above the level of the desk. Karlqvist et al (1996) found that working at least 5.6 hour a week with a computer mouse increased the risk of MSS in the shoulder joint, elbow, wrist and hand or fingers. Demure et al (2000) also found an increased risk for wrist/hand, neck and shoulder numbness among persons using computer more than seven hours per day, as compared to more than three hours. Although all of these previous studies supported this study findings in which most of respondents spent more than six hours using VDU screen can resulted in MSS, however, for this case, the duration of VDU use only affected their shoulders, upper back and lower back.

Demure et al (2000) found that 'poor keyboard position' increased wrist/hand discomfort, however, the 'poor layout' of the workstation, interestingly, decreased wrist/hand discomfort. It can be said that wrist/hand discomfort did not influence by workstation layout. It is different from this study, wrist/hands raised the risk of MSS by the chair, desk, and accessories factor but not in the factor of VDU screen, keyboard and mouse. Sillanpaa et al (2014) have done a study among office workers and found the placement of the mouse beside the keyboard showed an elevated risk for finger pain. This may have caused finger pain due to the unsatisfactory room for the mouse and the need to raise the mouse to make movement possible. Cook, Burgess-Limerick, and Chang (2000) found an association between the neck and arm abduction symptoms specific to mouse use. It is reasonable to assume that long periods of VDU use, sitting in a chair and study no doubt contribute to a large proportion of MSS among undergraduate students. Long periods of improper sitting posture in front of VDU may also be related to MSS of the one or both hips/thighs in the current study. It might be due to the factor of most of respondents (69.6%) sit for a long time in one position and did not regularly do some stretching exercises.

National Institute of Occupational Safety and Hygiene (2020) revealed that most employees conduct their activities in spaces designed for home life, such as dining rooms, living rooms, or bedrooms, and nearly half of these environments do not have adequate furniture, leading to the conclusion that workplace design does not fit from an ergonomic point of view. The current study found that home situation is one of the factor increased the risk of MSS on neck, shoulder and ankles. These findings are consistent with other studies which reported that 67% of users who work in the bedroom use a laptop computer and work while lying in bed experienced neck discomfort. In addition, more than half of the workers reported lumbar problems (57.4%), due to the postures adopted in the workplace at home are not adequate (Larrea-Araujo et al., 2021).

Table 5
Association between VDU exposures and MSS risk in the nine body regions (N=358)

M usculoskeletal Symptoms	xposure/ isk Level	Odd Ratio (95% CI)								
		eck	houlder	lbow	rists/ Hands	pper Back	ower Back	ne or Both Hips/ Thigh	ne or Both Knees	ne or Both Ankles / Feets
H ours per day use a VDU screen for ODL	-4 hours	.580 (0.593; 4.211)	.033 (0.774; 5.339)	.631 (0.141; 2.811)	.497 (0.901; 6.919)	.276 (0.865; 5.989)	.323 (0.896; 6.022)	.679 (0.200; 2.313)	.996 (0.796; 11.279)	.361 (0.396; 4.679)
	-6 hours	.290 (0.882; 5.944)	3.369 (1.322; 8.590)	.266 (0.330; 4.849)	.376 (0.893; 6.325)	.076 (0.820; 5.254)	*3.534 (1.407; 8.876)	.425 (0.464; 4.376)	.141 (0.582; 7.880)	.770 (0.547; 5.731)
	ore than 6 hours	.207 (0.869; 5.606)	* 4.335 (1.711; 10.987)	.046 (0.275; 3.988)	.189 (0.832; 5.758)	* 3.337 (1.330; 8.372)	*4.186 (1.682; 10.419)	.180 (0.388; 3.591)	.397 (0.662; 8.685)	.935 (0.607; 6.167)
C hair, desk, and accessories	edium Risk (2-4)	.364 (0.069; 1.920)	**10.447 (3.855; 28.309)	12.385 (1.406; 109.108)	0.288 (0.095; 0.870)	*4.675 (1.738; 12.577)	.625 (0.985; 6.993)	*10.726 (2.177; 52.861)	3.831 (1.104; 13.296)	.869 (1.219; 12.284)
	igh Risk (5-10)	0.177 (0.035; 0.892)	**5.280 (2.077; 13.419)	11.685 (1.338; 102.074)	*0.234 (0.080; 0.685)	**4.848 (1.849; 12.713)	.581 (0.637; 3.922)	5.692 (1.157; 28.006)	.321 (0.972; 11.346)	.382 (0.756; 7.504)
W orking hours and (micro) breaks	edium Risk (2-4)	.721 (0.265; 1.966)	.566 (0.220; 1.456)	.612 (0.350; 7.424)	.536 (0.640; 3.685)	.837 (0.351; 1.992)	.928 (0.377; 2.282)	.743 (0.269; 2.054)	.580 (0.512; 4.878)	.797 (0.583; 5.545)
	igh Risk (5)	.982 (0.287; 3.366)	.554 (0.186; 1.649)	.645 (0.695; 19.125)	.243 (0.802; 6.270)	.703 (0.254; 1.942)	.133 (0.388; 3.312)	.033 (0.312; 3.424)	.058 (0.875; 10.685)	.704 (0.476; 6.093)
Si tting posture and working technique	edium Risk (2-4)	.682 (0.155; 18.224)	.093 (0.383; 24.990)	.578 (0.052; 6.362)	.524 (0.051; 5.411)	.625 (0.060; 6.513)	.077 (0.102; 11.412)	.383 (0.048; 3.067)	.859 (0.081; 9.084)	.424 (0.134; 15.090)
	igh Risk (5-9)	.475 (0.141; 15.400)	.341 (0.426; 26.193)	.470 (0.045; 4.920)	.298 (0.030; 2.982)	.376 (0.037; 3.804)	.301 (0.126; 13.433)	.338 (0.044; 2.587)	.041 (0.102; 10.576)	.500 (0.147; 15.321)
T he home situation	edium Risk (2-4)	.042 (0.380; 2.859)	.808 (0.332; 1.967)	.588 (0.195; 1.775)	.753 (0.329; 1.722)	.183 (0.533; 2.626)	.782 (0.318; 1.923)	.565 (0.229; 1.393)	.790 (0.327; 1.912)	.485 (0.212; 1.108)

Significance at: *p<0.05, **p<0.01, ***p<0.001; Statistical test: Logistic Regression; CI: Confidence Interval

Study Limitations

There were some unavoidable limitations while conducting this study. First, profession related tasks such as nursing students with long clinical session who might exposed to bad posture may influenced this study findings. Other than that, this study contained jargon words, which is a less known topic among general population. This study also did not involve any intervention measures of MSS as it only assess current condition when the study was conducted. The sample size population also did not represent the whole undergraduate students in all university as the study only conducted in Universiti Sains Malaysia, Health Campus. However, this study is very useful as respondents will receive information on ergonomic risk factors they might pose during open and distance learning and the occurrence of musculoskeletal symptoms. In addition, the information from this study can help university management to plan an ergonomic awareness program for students to reduce the risk of musculoskeletal disorders. This study was conducted by using validated questionnaire that was inexpensive. The study findings can be beneficial for future research especially in developing guidelines and procedures on ergonomic risk assessment for students when using with VDUs.

Conclusion and Implications

Overall, it is evident that improper or poor workstation layout may lead to high risk of musculoskeletal symptoms. Therefore, this study confirmed the importance of proper design of workstation and providing postural education to students in using VDU. From the perspectives of overall respondents, majority of respondents had ache, pain, discomfort and numbness for neck, shoulder, wrists/hands, upper back and lower back for the last 6 months. In summary, this study indicated that most of respondents exposed to MSS due to VDU use during ODL. There is no existing guidelines related to ergonomic among students, hence, this study might be a good start as a reference. In Malaysia, data and statistics of ergonomic risk factors and musculoskeletal symptoms among students during open and distance learning are limited. Most of the data are focusing on workers, but not students. Thus, the knowledge of VDU risk factors and MSS among students might be less, and this may cause the development of MSS among students to increase. Therefore, this study findings is essential to gather data on VDU risk factors and MSS among students to increase their awareness of these issues.

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