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FACTORS ASSOCIATED WITH COMPUTER VISION SYNDROME AMONG STUDENTS LEARNING FROM HOME DURING COVID-19 PANDEMIC IN MALAYSIA

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BY

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ABSTRACT

FACTORS ASSOCIATED WITH COMPUTER VISION SYNDROME AMONG STUDENTS LEARNING FROM HOME DURING COVID-19 PANDEMIC IN MALAYSIA

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Introduction: Following the COVID-19 pandemic, many routine and daily livelihood activities in Malaysia has been restricted as the government intermittently enforced MCO in various part of the country corresponding to the severity of cases – incidence of infection. Among affected activities were the education sector where most, if not all educational institutions deemed to be non-essential were forced to adopt and adapt online teaching and learning mechanism as an alternative. As such, there is a potential concern that the students may be at risk of developing computer vision syndrome (CVS) following prolonged exposure to the electronic display screen of their devices such as desktop computer, laptop, mobile phone, etc. as they learn from home. **Objective:** To determine the factors associated with CVS among students learning from home during COVID-19 pandemic in Malaysia. **Methodology:** A nationwide cross-sectional study was conducted among universities students in Malaysia which employed convenience sampling for data collection. A validated and pre-tested online questionnaire were distributed via social medias. Data obtained was exported to IBM SPSS Version 25 for statistical analysis. **Result:** A total of 657 respondents were left for data analysis after excluding incomplete responses. Most of the respondents were female (76.3%) with mean age of 21 years old (SD = 2.0). The results showed the prevalence of CVS in the past 1 week among students learning from home was 71.2%. There were significant associations between computer vision syndrome with gender ($\chi^2 = 9.382$, $p = 0.002$), duration of physical exercise ($r = 0.095$, $p = 0.015$), time spent on hobby ($r = 0.089$, $p = 0.022$), mobile phone usage for learning activities ($\chi^2 = 6.044$, $p = 0.015$), using floor as workstation ($\chi^2 = 8.689$, $p = 0.003$), using bed as workstation ($\chi^2 = 4.159$, $p = 0.045$), sitting with upper body twisted sideways ($\chi^2 = 10.248$, $p = 0.006$) and neck twisted sideways ($\chi^2 = 7.499$, $p = 0.023$) when engaging online learning as well as student with vision corrected ($\chi^2 = 8.988$ $p = 0.03$). **Conclusion:** The prevalence of self-reported CVS in a past week among the respondents in this study is a significant health concern which may affect the quality of learning among the students. Amongst the factors found significantly associated with the prevalence of CVS, vision correction, time spent on floor as workstation and twisting of upper body sideways are of particular concern which predict the prevalence of CVS.

Keywords: learning from home, ergonomics, computer vision syndrome

ABSTRAK

FAKTOR BERKAITAN SINDROM PENGLIHATAN KOMPUTER DI KALANGAN PELAJAR BELAJAR DARI RUMAH SEMASA PANDEMIK COVID-19 DI MALAYSIA

SITI AINA NABIHA BINTI ZAKARIA

Pendahuluan: Berikutan wabak COVID-19, pelbagai rutin dan aktiviti kehidupan harian terbatas apabila kerajaan menguatkuasakan PKP di pelbagai kawasan di dalam negara secara berkala berdasarkan intensiti kes-kejadian jangkitan. Antara aktiviti yang terjejas adalah sektor pendidikan, yang mana institusi pendidikan terpaksa menggunakan dan mengadaptasi mekanisme pengajaran dan pembelajaran dalam talian sebagai kaedah alternatif. Oleh itu, terdapat kemungkinan bahawa pelajar berisiko menghidapi sindrom penglihatan komputer berikutan pendedahan yang berpanjangan terhadap skrin paparan peranti elektronik seperti komputer desktop, komputer riba, telefon bimbit dan lain-lain. **Objektif:** Untuk menentukan faktor-faktor yang berkaitan dengan prevalens sindrom penglihatan komputer di kalangan pelajar yang belajar dari rumah semasa pandemik COVID-19 di Malaysia**. Metodologi:** Satu kajian keratan rentas dilaksanakan di kalangan pelajar di Malaysia dengan mengambil sampel kemudahan untuk pengumpulan data. Soal selidik dalam talian yang telah disahkan dan diuji diedarkan melalui media sosial. Data yang diperoleh kemudiannya dieksport ke IBM SPSS Versi 25 untuk analisis statistik**. Keputusan:** Sebanyak 657 responden diperoleh bagi analisis data setelah ditolak bilangan responden dengan data yang tidak lengkap. Sebilangan besar responden terdiri daripada pelajar perempuan (76.3%) dan usia min pelajar adalah 21 tahun (SD = 2.0). Hasil kajian menunjukkan bahawa prevalens sindrom penglihatan komputer dalam 1 minggu kebelakangan di kalangan pelajar yang belajar dari rumah adalah 71.2%. Terdapat hubungan yang signifikan antara sindrom penglihatan komputer dengan jantina (χ^2 = 9.382, p = 0.002), jangka masa latihan fizikal (r = 0,095, p = 0,015), masa yang dihabiskan untuk hobi (r = 0,089, p = 0,022), penggunaan telefon bimbit untuk aktiviti pembelajaran (χ^2 = 6.044, p = 0.015), menggunakan lantai sebagai stesen kerja (χ^2 = 8.689, p = 0.003), menggunakan tempat tidur sebagai stesen kerja (χ^2 = 4.159, p = 0.045), duduk dengan badan atas berpusing ke sisi (χ^2 = 10.248, p = 0.006) dan leher berpusing ke sisi (χ^2 = 7.499, p = 0.023) semasa melibatkan pembelajaran dalam talian serta pelajar dengan penggunaan kaca mata (χ^2 = 8.988, p = 0.003). **Kesimpulan:** Prevalens sindrom penglihatan komputer yang dilaporkan dalam seminggu yang lalu di kalangan responden dalam kajian ini adalah masalah kesihatan yang signifikan yang boleh mempengaruhi kualiti pembelajaran di kalangan pelajar. Di antara faktor-faktor yang secara signifikan berkaitan dengan prevalens sindrom penglihatan komputer, penggunaan kaca mata, masa yang dihabiskan di lantai sebagai stesen kerja dan duduk dengan badan atas berpusing ke sisi menjadi perhatian khusus yang meramalkan berlakunya sindrom penglihatan komputer.

Kata kunci: belajar dari rumah, ergonomik, sindrom penglihatan komputer

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LIST OF ABBREVIATIONS

CVS	Computer Vision Syndrome
MCO	Movement Control Order
CMCO	Conditional Movement Control Order
COVID-19	Coronavirus Disease
JKEUPM	Jawatankuasa Etika Universiti untuk Penyelidikan Melibatkan Manusia
VDT	Visual Display Terminal

CHAPTER 1

INTRODUCTION

1.1 Study Background

Corresponding to the rapid technological development, the Malaysian education sector has also undergone various innovation brought by the rise of computer technology to produce graduates with computer skills. Computer development in Malaysia was initiated by computer-in-education (CIE) project in early 1990 (Abas, 1995). The project was to introduce information technology on a national scale. It was envisioned that the country will be able to provide a society with communication technology skills to meet the demands of industrialized country by 2020.

Among the segment of population in education sector in need of the use of computer technology are university students. A computer technology is a common tool among university students for information search, writing assignment or research and communications (Reddy et al., 2013). The usage of computer in education among students for learning and teaching has been implement since 1990s in many countries (Sotoyama et al., 2002). The common feature of this type of device is visual display which function is to display the information output on the screen, which is a primary requirement to interact with the device was estimated that 45 to 70 million people spend hours staring at the screen (Akinbinu & Mashalla, 2014).

1.2 Problem Statement

Following a surge of COVID-19 cases beginning Oct 2020, the government has intermittently re-enforced the conditional MCO in various part of the country (Majlis Keselamatan Negara, 2020). The MCO which depends primarily on the severity of infection based on daily infection cases and locality of cluster affected daily livelihood and business operation throughout the country including education sector. With the

closure of schools and campuses, students had to be sent back home which forced the educational institution to switch to online teaching and learning. Due to the situation, students' exposure to electronic devices such desktop computers, laptops and other similar platform increases significantly.

Despite the technology development of desktop computer, laptop and other similar device, poor practice and environmental conditions while learning using computer has been shown to cause computer vision syndrome among the students (Abudawood, Ashi & Almarzouki, 2020). A previous study even before MCO has shown that students using computer continuously for more hours are at high risk to develop computer vision syndrome (Afshan et al., 2017). The enforcement of MCO and subsequent closure of campus became a more significant concern as students is expected to spend more time staring at the screen for learning, assignment and research work as they learn from home.

Computer vision syndrome is a common health problem which symptoms experienced were always ignored and neglected by the user where the symptoms may minimize job performance and satisfaction (Zairina & Suhaila, 2011). Previous studies have also found that computer vision syndrome does not only cause eye discomfort but were usually accompanied by musculoskeletal disorders such neck and back pain which could further impair users' productivity and reduce the quality of life resulting from unusual strain on physical well-being (Akinbinu & Mashalla, 2014).

It is known that computer vision syndrome is a condition that can be experienced by computer users. However, the conditions and practices that can cause computer vision syndrome among students learning from home via online teaching and learning conducted due to the pandemic is a significant concern which warrant consideration as they may potentially cause decline not just in their health but also quality of their education and in that the knowledge transfer process.

1.3 Study Justification

This study is expected to provide an insight on the prevalence of health effects (specifically vision related discomfort as well as neck and shoulder pain) and the relationship of the health effects with potentially increased and prolonged exposure to the visual display devices among universities' students learning at home corresponding to the usage of computer and others similar device.

Specifically, the sociodemographic characteristics and factors associated with CVS will provide insight to current condition and practices during the COVID-19 pandemic. It is hoped that the data provided by this study will be a basis or essential reference for development of guidance or design of intervention to reduce the adverse health effect for the universities' students within the scope of predicament in this study.

1.4 Objectives

1.4.1 General Objectives

To determine the factors associated with computer vision syndrome among students learning from home during COVID-19 pandemic in Malaysia.

1.4.2 Specific Objectives

i) To identify socio-demographic background (gender, race, age, education status, body mass index, locality and total household income), social lifestyle (smoking, alcohol intake, duration of sleep, duration of physical exercise and duration of hobby), characteristics and usage of electronic devices (type of device, input device, keyboard, chair and workstation, exposure time and characteristic of workstation) among students learning from home during the COVID-19 pandemic.

ii) To determine the prevalence of computer vision syndrome among students learning from home during the COVID-19 pandemic.

iii) To determine the association between socio-demographic background (gender, race, age, education status, body mass index, locality and total household income), social lifestyle (smoking, alcohol intake, duration of sleep, duration of physical exercise and duration of hobby), characteristics and usage of electronic devices (type of device, input device, keyboard, chair and workstation, exposure time and characteristic of workstation) with computer vision syndrome among students learning from home during COVID-19 pandemic.

iv) To determine the predictors associated with the computer vision syndrome among students learning from home during COVID-19 pandemic.

1.5 Hypothesis

i) There is a significant association between socio-demographic background (including gender, race, age, education status, body mass index, locality and total household income), social lifestyle (smoking, alcohol intake, duration of sleep, duration of physical exercise and duration of hobby), usage of electronic devices (type of device, input device, keyboard, chair and workstation, exposure time and characteristic of workstation) with computer vision syndrome among students learning from home during COVID-19 pandemic in Malaysia.

ii) There are significant contributing predictors of the prevalence of computer vision syndrome among students learning from home during COVID-19 pandemic in Malaysia.

1.6 Conceptual Framework

Based on the conceptual framework (Figure 1.1), this study focused on the effects of increased usage of the visual display devices among universities' students learning from home following the closure of higher educational institutions in light of COVID-19 pandemic. Instead of the traditional face-to-face learning mechanism, the virtual or

online learning increased students' exposure to the usage of electronic devices, including tablets, laptop, computer and phone as learning medium and tool.

Figure 1.1 shows all variables that was included in this study. The population studied were students learning from home during COVID-19 pandemic in Malaysia. The dependent variable in this study was computer vision syndrome (CVS) denoting the negative health outcomes of increased exposure to usage of electronic devices due to the COVID-19 pandemic mitigation measures primarily by physical distancing.

The independent variables could be divided into two categories: individual factors and other factors. Individual factors were the socio-demographic background of the students which included information on gender, race, age, body mass index, education status, locality and total household income which has been reported in previous studies to potentially affect the CVS outcomes (Zairina & Suhaila, 2011; Ranasinghe et al., 2016; Dessi et al., 2018).

Other factors which potentially contribute to CVS based on previous study were the usage of electronic devices which could be further divided into three categories: type of device, input devices, keyboard, chair and workstation, exposure time and characteristics of workstation (Kermit et sl., 2020; Ranasinghe et al., 2016; Zairina & Suhaila, 2011; Muthunarayanan et al., 2013).

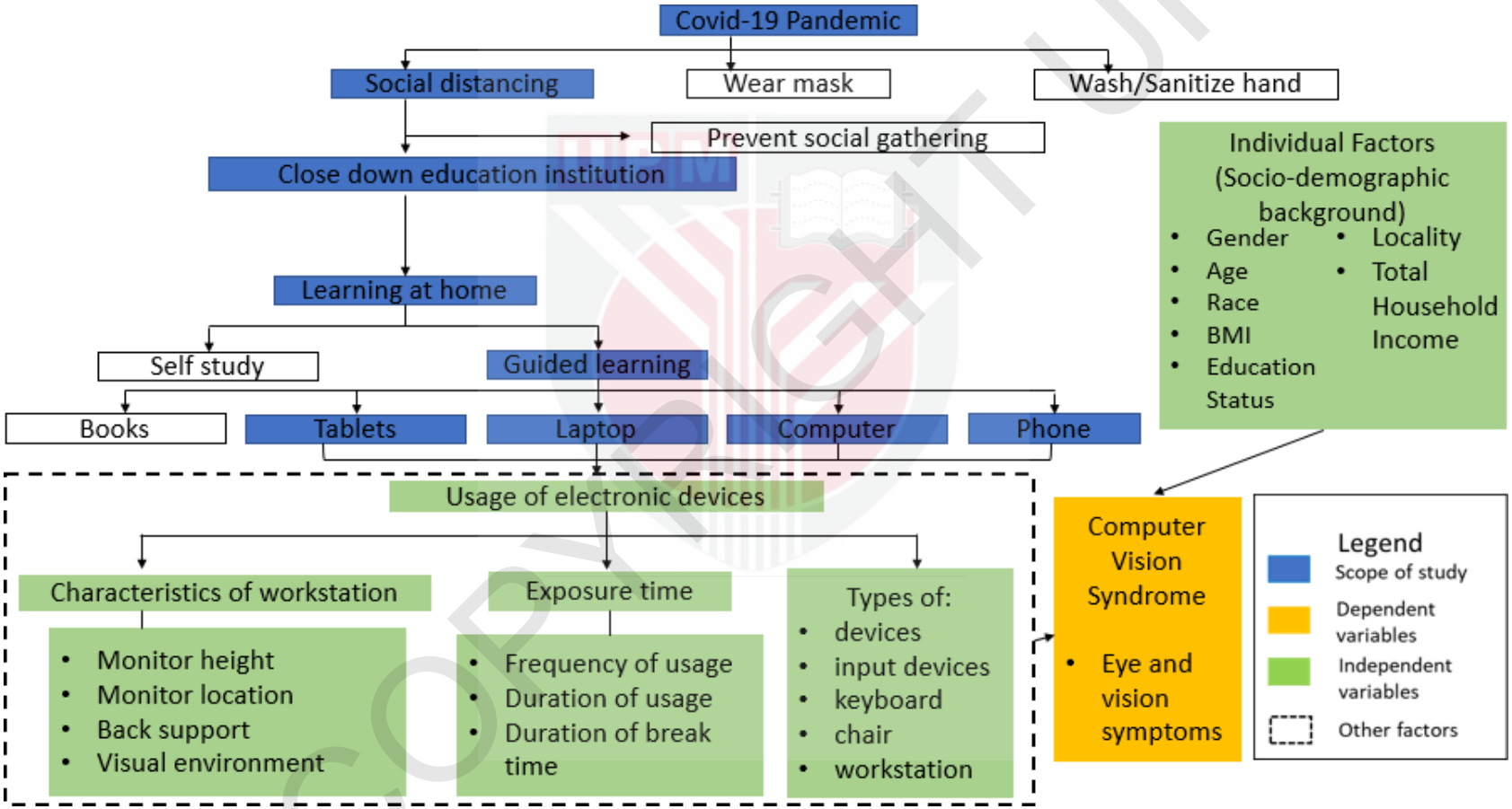

Figure 1.1: Research conceptual framework of factor associated with computer vision syndrome among students learning from home during COVID-19 Pandemic in Malaysia.

1.7 Definitions

1.7.1 Conceptual Definitions

1.7.1.1 Computer Vision Syndrome

Computer vision syndrome is a complex eye and vision symptoms, including eye pain, eye redness, blurred vision, increase sensitivity to light that related to near work that are experienced during or related to computer use (American Optometric Association, n.d.).

1.7.1.2 Socio Demographic Background

Socio demographic is a sociological and demographic attribute acquired by an individual(s) in a population, where sociological referred to cultural and environmental factors while demographic referred to distinct characteristics of the individual (Kabir, 2018).

1.7.1.3 Electronic Devices

Electronic devices are devices that is cell phone, a computer, and any other device that is capable of transmitting, receiving, or recording messages, images, sounds, data, or other information by electronic means or that, in appearance, purports to be a cell phone, computer, or such other device (Law Insider, n.d.)

1.7.2 Operational Definition

1.7.2.1 Computer Vision Syndrome

Computer vision syndrome in this study are operationally defined as symptoms of eye pain, eye redness, blurred vision, increase sensitivity to light which will be determined by questionnaire established from study conducted by Seguí et al. (2014).

1.7.2.2 Socio Demographic Background

Socio-demographic background were the sociological and demographic background, including age, race, gender, education status, body mass index, locality and total household income which will be determined by using questionnaire.

1.7.2.3 Usage of Electronic Devices

Usage of electronic devices are usage of cell phone, a computer, and any other device determined by questionnaire adapted from study conducted by Kermit et al. (2020), Sellschop (2015) and Hatfield & Ciccarelli (2010).

CHAPTER 2
LITERATURE REVIEW

2.1 Computer Vision Syndrome (CVS)

Gowrisankaran and Sheedy (2015) defined computer vision syndrome as compilation of visual, ocular and musculoskeletal symptoms resulting from extended computer usage over certain period. Based on American Optometric Association, CVS is defined as "complex of eye and vision problems related to near work that are experienced during or related to computer use".

Even though, CVS by medical definition is not a disease, CVS is well known to be a "series of symptoms that are common to those who experience computer related eye discomfort" (Anshel, 2005). Thus, computer vision syndrome can be defined as a compilation of eye and vision symptoms experienced during or related to exposure of excessive computer use.

Symptoms of computer vision syndrome can vary. Most commonly computer vision syndrome symptoms include eye discomfort such headache, blurred vision, double vision, eye redness, dryness, increased sensitivity to light and also neck and back pain.

2.1.1 Headache

Akinbinu and Mashalla (2014) describe headache as one of the common symptoms which affect many computer users. Headaches are among major reason for people who went for an eyes check-up. There are many differential diagnoses of headache which can be either visual or non-visual related headache. Computer users are prone to experience tension-type headache which can be attributed to "stress, including anxiety and depression, numerous eye conditions, including astigmatism and hyperopia, improper workplace conditions including glare, poor lighting, and improper workstation set up (Anshel, 2005).

2.1.2 Blurred Vision

Blurred vision is fuzzy visual images or less focus vision caused by lack of ability to see the sharpness and fine detail. Anshel (2005) stated that blurred vision can occurred because of several factors at working environment including poor viewing angle, glare, poor quality and defective monitor. Anshel (2005) also stated that viewing monitor for extended period of time caused a point to which eye actually focusing behind target being viewed increases. In this condition, eye muscle had to expend more effort to focus on the details on a screen and in the event of failure, resulting in blurred vision.

2.1.3 Double Vision

Double vision is an uncomfortable condition where the eyes lose the ability to 'lock' between the eyes and making misalign, where both eyes will continuously transmit image back to brain, producing double vision (Anshel, 2005). A person who experiences double vision will tend to close one of the eyes or further focused on the image. Double vision can be caused by glaring for a long period of time where the strain to the eye becomes greater with shorter distance (Collins et al., 1975). Anshel (2005) further describe that when viewing near-point object, the extraocular muscle converges the line of sight of the eyes inward toward the nose, producing strain around muscle resulting in double vision.

2.1.4 Dryness

Dry eyes in computer vision symptom are different from the dry eyes commonly experienced by elderly above 60 years old. Anshel (2005) described that decrease in blinking activity affect the tear production, where intermediately cause stress to the cornea, resulting in dry eyes. The tears help in maintaining proper oxygen balance and keep optical properties of the eye sharpness. Decrease in blink rate can be caused by the relative limited range of eye movements due to prolonged focus or concentration in visually demanding task. Thus, monitor viewing can caused significantly decreased blinking compared to reading book as monitor which visual images are produced

electronically has refresh rates that may be visually demanding resulting in higher rate of tear evaporation and eventually cause eye dryness.

2.1.5 Increased Sensitivity to Light

The eyes are a complex anatomical structure with muscles that stimulates and control the amount of light entering the eyeball. In the advent of technological development and the sophistication of social lifestyle, artificial light source has become abundantly available; used to extent that the term "light pollution" is coined (Anshel, 2005). In the case of electronic devices usage, the artificial light source from the device is able to stimulate adverse reaction to the eye (Anshel, 2005). The author also describes that one major factor which contributes to light sensitivity while using electronic devices is glare. Glare can be further divided into two categories of glare which are discomfort glare and reflective glare.

2.2 Prevalence of Computer Vision Syndrome

Table 2.1 showed a summary on the frequencies of individual symptoms including the prevalence of computer vision syndromes reported by previous studies. Headache, blurred vision, and eye redness appeared to be common symptoms experienced by many computer users where the prevalence of headache (61%) and blurred vision (62.60%) were among the highest reported by Sen and Richardson (2007) and Dessie et al. (2018) respectively.

The prevalence of eye redness among computers users reported by Shrivastava and Bobhate (2012) among software professional, Talwar et al. (2009) among computer professional, Sen and Richardson (2007) among university students and Dessie et al. (2018) among university students were 40.2%, 40.7%, 46% and 40.28% respective which saw quite a consistent trend despite between different population group at different time period.

Table 2.1: Prevalence of computer vision syndrome symptoms from previous studies

Authors (Year)	Symptoms of Computer Vision Syndrome						Prevalence of Computer Vision Syndrome	Remarks (Instruments Used)
	Headache	Blurred vision	Double vision	Eye redness	Dryness	Increased sensitivity to light		
Shrivasta and Bobhate (2012)	-	-	-	40.20%	-	-		Visual Complaints Questionnaire
Iqbal et al. (2018)	26.00%	31.00%	-	15.00%	28.00%	-	86.00%	CVS Survey Questionnaire Form
Talwar et al. (2009)	-	-	-	40.70%	-	-		Experience of Visual Problems Questionnaire
Abudawood et al. (2020)	-	11.40%	5.40%	15.10%	20.30%	16.20%	95.00%	An Electronic Survey adapted from previous literature research on CVS
Reddy et al. (2013)	19.70%	10.20%	-	-	-	-	89.90%	Research Questionnaire for Computer Vision Syndrome
Muthunarayanan et al. (2013)	24.30%	-	-	18.70%	-	-		Questionnaire on Symptoms of CVS
Sen and Richardson (2007)	61.00%	-	-	46.00%	-	-		Questions on Symptoms of CVS
Dessie et al. (2018)	33.65%	62.60%	22.75%	40.28%	22.27%	-		Symptoms of CVS Questionnaire
Zairina & Suhaila (2011)	-	-	-	-	-	-	68.10%	Questions of CVS Symptoms
Huda & Muhammad (2014)	-	-	-	-	-	-	63.00%	Symptoms of CVS Questionnaire

On the other hand, Reddy et al. (2013) reported that 28% of the respondents in their study among university students in Malaysia experienced eye dryness as compared to 20.3% and 22.7% by Abudawood et al. (2020) and Dessie et al. (2018). Study by Abudawood et al. (2020) further reported that 16.2% of their study population complained of being increased sensitivity to light.

In terms of the prevalence of computer vision syndrome among medical students, Iqbal et al. (2018) in their study revealed a significant concern of 86.0% which was reinforced by findings reported in Abudawood et al. (2020) who reported 95.0% among undergraduate medical students. Among universities students, a study by Reddy et al. (2013) found that the prevalence of computer vision syndrome was 89.9%.

Zairina and Suhaila (2011) which respondents were academician and administrative staff in a local University reported 68.1% had CVS which was pretty similar to the results obtained by Huda and Muhammad (2014) at 63%.

2.3 Risk Factor of Computer Vision Syndrome

2.3.1 Sociodemographic Background

Several previous studies revealed significant association between prevalence of computer vision syndrome and gender. Zairina and Suhaila (2011) indicated that there was a significant difference on the prevalence of computer vision syndrome between male and female with. Female showed higher risk of developing computer vision syndrome compared to male which was similarly reported by Ranasinghe et al. (2016).

Besides that, study by Huda and Muhammad (2014) also found gender being significantly associated but with knowledge on visual ergonomics where male showed poorer knowledge on visual ergonomics as compared to females. Among others, monthly salary and occupational status were reported in a previous study as factors which significantly predict the prevalence of computer vision syndrome among computer users (Dessie et al., 2018).

2.3.2 Duration of Exposure

Visual task which requires prolonged duration of digital screen usage makes the eye muscle work harder which can lead to computer vision syndrome when the demand exceeds the visual abilities (Anshel, 2005). Blehm et al. (2005) recorded that 90% of the US workers who use computer longer than 3 hours a day develop computer vision syndrome in some form of the symptoms.

Punnett and Bergqvist (1997) as well as Klomm and Tarnow (2015) described that risk factors contribute to pain and discomfort related to computer usage were frequency, duration of computer use, and time spent using the computer without break. In that, Saurabh et al. (2012) observed that taking break of 5 minutes for every hour of screen viewing reported to decrease the eye discomfort.

2.3.3 Display Screen Position

The position of display screen significantly affects the posture of the users. Specifically, Muthunarayanan et al. (2013) described that display screen which is positioned at elevated height require users to look upward increases the risk to develop symptoms of CVS which includes eye redness, burning sensation, headache, blurred vision and dry eyes compared looked at computer screen at the same level.

The findings by Muthunarayanan et al. (2013) was agreed in a study by Jaschinski et al. (n.d.) and Reddy et al. (2013). The authors further describe that the alternate; viewing the display screen downwards were also at higher risk to develop CVS. Besides that, Klomm and Tarnow (2015) observed that computer vision syndrome caused by computer viewing distance from monitor or screen less than 20 inches away.

Based on a review of literature on computer vision syndrome by Klomm and Tarnow (2015), the authors revealed that good posture in a comfortable environment help to reduce risk in develop computer vision syndrome.

2.3.4 Lighting

Tribley, McClain, Karbasi and Kaldenberg (2011) emphasized the usage of proper lighting at workstation where lighting of the workstation should be half of normal room lighting and glare avoided using anti-reflection film or other adjustment available for reducing glaring at the screen. Klomm and Tarnow (2015) reported that computer vision syndrome caused by lack anti-glare cover or reflective coating on computer screen. Computer user who did not do screen adjustments to avoid glaring were at high risk to develop blurred vision, burning sensation and dry eyes (Muthunarayanan et al., 2013). Thus, sufficient lighting and adjustment at workstation and computer are in need for treating computer vision syndrome among the computer users.

2.3.5 Vision correction

Blehm et al., (2005) observed that spectacle wearers were in need to moving back and forth as well as change posture to have a clear and focus vision. These movement had caused neck stress and eye fatigue. Study by Ready et al., (2013) revealed that students who wear spectacles experienced eye symptoms of computer vision syndrome more frequent than those who did not wear spectacles. Contact lens wearers were also at risk to experience dry eyes and blurred vision due to infrequent blinking (Wiggins et al., 1992). Therefore, a person with vision correction may exposed to computer vision syndrome.

2.4 Research Gap

There has been numerous study available on computer vision syndrome, including study on the prevalence and risk factors associated to the of computer vision syndrome. However, there is limited study on computer vision syndrome related to computer usage at home among student in Malaysia.

Besides that, it was also found that study related to other type of devices besides desktop computer and laptop use among students learning at home in Malaysia was limited. Studies in other countries show that mobile phone was commonly used among students for learning activities.

A study by Tegoe (2014) revealed that there was high rate of adoption in usage of mobile phone in distance learning. A study conducted by Tuncay (2016) highlighted that smartphone has made learning activities via distance mode effective compared to laptop. This was further supported from a comment by Darko (2019) that the use of smartphone has become latest trend in higher education.

Those studies were in agreement that students in this era no longer need to rely on laptop or desktop computer to access academic material or to perform assignment or education task, where a smartphone makes it more possible to access academic material and perform academic task at any time and at instance.

However, the fact that there is limited study on the workstation condition during online learning from home among students cannot be undermined. It is believed that students may not only use specific learning desk or have access to certain furniture or accessories during online learning due to resources limitation.

Alternative learning workstation that includes dining table, chair, sofa, floor, and bed are possibly to be use as learning workstation by the students. There is possibility that using electronic device for online learning at these alternative learning workstations may increase the risk in develop computer vision syndrome.

In summary, there was insufficient data reporting on the current type of electronic device use and learning workstation condition at home since the implementation of teaching and learning among students in Malaysia. These have caused some difficulty to assess usage of electronic devices and workstation set up at home that could be contribute to computer vision syndrome.

CHAPTER 3
METHODOLOGY

3.1 Study Design

This was a cross sectional study conducted from January to June 2021where the various factors potentially associated with computer vision syndrome among students learning at home were investigated.

3.2 Study Location

This study was conducted in Malaysia where no specific location provided, dependent upon the locality of the students learning from home during COVID-19 pandemic in Malaysia.

3.3 Sampling Method

3.3.1 Sampling Strategy

The sampling technique of this study was convenience sampling where the universities' students were recruited by disseminating questionnaire in the form of online survey using several platforms, including email, WhatsApp, Facebook and Telegram in order to maximize outreach.

3.3.2 Sample Population

The target population for this study were university students learning from home during COVID-19 pandemic in Malaysia.

3.3.3 Sampling Unit

The respondents in this study were those who fulfilled the criteria outlined in the next subchapters.

3.3.3.1 Inclusion Criteria

The inclusion criteria of this study are:

i. students enrolled in universities
ii. full time foundation (under universities' program), diploma (under university program), undergraduates and postgraduate student and
iii. using any of the following devices for learning from home:
    a. laptop computer
    b. desktop computer
    c. tablet
    d. phone

3.3.3.2 Exclusion Criteria

The exclusion criteria of this study were student(s) who has deferred their study.

3.3.4 Sample Size

Sample size for this study was calculated by using sample size calculation as prescribed by Lemeshow et al., (1990) with the following assumptions:

$$N = \frac{(z^2)[P_1(1-P_1) + P_2(1-P_2)]}{d^2}$$

Where,

N = sample size

z = 1.96 for 95% confidence interval

P_1= Prevalence of computer vision syndrome among female from previous study by Zairina and Suhaila (2011) = 69% = 0.69

P_2= Prevalence of computer vision syndrome among male from previous study by Zairina and Suhaila (2011) = 31% = 0.31

d = 0.05 for desired precision

Therefore,

$$N = \frac{(1.96^2)[0.69(1-0.69)+0.31(1-0.31)]}{0.05^2}$$

$$N = 657 \text{ respondents}$$

Based on the formula, sample size for this study is 657 respondents. To reduce error due to the nonresponsive respondents, response rate target is set. Average online survey response rate among higher education is 33% (Nulty, 2008).

Response rate target = sample size / (response rate)
= 657/ (33/ 100)
= 1990

Where,

sample size = 657, and

response rate = 33/100 (where response rate is 33%).

Hence, the questionnaire needs to be disseminated to at least 1990 individual in order to achieve sample size target of 657 respondents with the assumption that only 33% of the 1990 individual who received the questionnaire responded.

3.4 Instruments

The primary instrument used as instrument for this study was online questionnaire survey which consist of four sections as attached in Appendix A, B, C and D. The four sections will be on socio demographic background, social lifestyle, ergonomic practices, and computer vision syndrome.

3.4.1 Section 1: Socio Demographic Background

This section focused on the background and characteristic of the population. Based on the study, the questions of socio demographic background collected were gender, age, race, body mass index, locality, education status, and total household income as provided in Appendix A.

3.4.2 Section 2: Social Lifestyle Questionnaire

This section focused on the lifestyle of the respondent during the period they were learning from home including. As provided in Appendix B, the questions were on average time spent on sleep, average time spent on physical exercise, average time spent on hobby (away from electronic devices), vaping or smoking activities, and alcohol consumption.

3.4.3 Section 3: Ergonomics Practices Questionnaire

This section focused on characteristics and usage of electronic devices for learning at home. The section of the questionnaire as attached in Appendix C was adapted from study conducted by Kermit et al. (2020). From the original ergonomics practices questionnaire used by Kermit et al. (2020), 8 questions related to characteristics and usage of electronic devices to identify associated factors of computer vision syndrome were included.

In the adaptation, 6 questions were removed as the questions were unrelated and literature review, there is no strong evidence that indicated them as risk factors of computer vision syndrome. The questions removed were questions related frequency of several type of worksurface, frequency of walking more than 5 min in a day, level of stress working in home office, level of tiredness working in home office, frequency of physical discomfort worked in normal office before COVID-19 and scale of discomfort in several body parts.

In the final questionnaire, the information collected from the questionnaire were:

1) Type of devices
2) Type of input devices
3) Type of keyboard
4) Type of workstation
5) Type of chair
6) Exposure time:
    a. Frequency of usage
    b. Duration of usage
    c. Duration of break time
7) Characteristic of workstation:
    a. Monitor height
    b. Monitor location
    c. Back support chair
    d. Visual environment
8) Vision correction

3.4.4 Section 4: Computer Vision Syndrome (CVS-Q)

This section which addresses the dependent variable was adopted from study conducted by Seguí et al. (2014). As provided in Appendix D, this section of the questionnaire requires the respondents to self-report experiences on the list of symptoms when using electronic devices. For each symptom, the respondent needs to mark how often the symptom occur and the intensity for:

1) Burning
2) Itching
3) Feeling of a foreign body
4) Tearing
5) Excessive blinking
6) Eye redness
7) Eye pain
8) Heavy eyelids
9) Dryness
10) Blurred vision
11) Double vision
12) Difficulty focusing for near vision
13) Increased sensitivity to light
14) Colored halos around objects
15) Feeling that sight is worsening
16) Headache

3.5 Data Collection Procedure

3.5.1 Preliminary Phase

This phase began with the preparation of the research proposal. Preliminary data for constructing the research was obtained by literature search on computer vision syndrome and the associated factors, where problem statement and the conceptual framework of this study was also constructed. Next, research proposal and related documents was submitted to UPM Ethics Committee to obtain Ethics Committee Approval.

3.5.2 Preparatory Phase

This phase involved the process of constructing questionnaire. The questionnaire was developed in adaptation of several previous studies. Pre-test and validity test were also conducted in this phase. Next, target respondents and dissemination platform were identified. The questionnaire was constructed into online questionnaire survey using the advanced version of the SurveyMonkey software.

3.5.3 Data Collection Phase

Constructed online questionnaire survey was disseminated to respondents in SurveyMonkey link through several virtual platforms. The virtual platforms used were email, WhatsApp, Facebook and Telegram. The questionnaire was sent via WhatsApp, Facebook and Telegram groups consist of students. The questionnaire was also sent to lecturers via email obtained through official websites of universities in Malaysia. The researcher, purpose of the questionnaire and the information to be collect were described in introduction of the online questionnaire survey.

3.6 Quality Control

3.6.1 Validity

Content validity test was conducted on several sections of the questionnaire including socio demographic background, social lifestyle and ergonomics practices. Content validity test for these sections was conducted by Professor Dr. Shamsul Bahri Haji Mohd Tamrin as an expert in the field of ergonomics. Appropriateness and relevancy of each item in the related sections of the questionnaire was determined by the expert.

Based on the validity test conducted, all items in the questionnaire rated as relevant and only minor correction for the questionnaire was conducted. The minor correction was conducted on section 2 and section 3 of the questionnaire. The minor correction conducted were the unit of hour and minutes were added in the answer column of the four questions related to average time spent on sleep, physical exercise, hobby and time spent at each learning workstation.

Next, vaping was included with questions related to smoking. Also, touch screen was added as one of the answer options of two closed-ended questions related to type of input device and keyboard use by students. A question asking whether the students take break during online learning was added. Lastly, questions related to duration of usage of electronic devices and duration of break time during online learning were changed from closed-ended questions into open-ended questions.

Face validity was conducted on the related sections in the questionnaire to assess the clarity of wording, layout and style of the questionnaire to the target audience. The face validity was conducted in conjunction with pre-test. Recommendations from the target audience were also included for the questionnaire improvement.

3.6.2 Pre-testing Questionnaire

A pre-test of the questionnaire was conducted among seventy respondents based on 10% of actual sample size. The pre-test was carried out between the researcher and the

targeted group through an online questionnaire survey. Following internal consistency of the questionnaire was measured using coefficient alpha represented as Cronbach's Alpha. As refer to Table 3.1 below, the test considered accepted and reliable when the value Cronbach's Alpha is 0.70 or above.

Table 3.1: Cronbach's alpha and internal consistency

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor

Table 3.2 shows the results of pre-test conducted only for the questionnaire on the Computer Vision Syndrome, Section 4. The Cronbach Alpha value found was 0.9, which indicate acceptable and excellent internal consistency (results as attached in Appendix E)

3.7 Data Analysis

Data collected was analysed using IBM SPSS Statistics Version 25 for all descriptive analysis, bivariate analysis and multivariate analysis.

3.7.1 Descriptive Analysis

3.7.1.1 Socio Demographic Background and Social Lifestyle

Descriptive analysis was used to obtained mean, standard deviation, frequency and percentage to assess socio demographic background among students learning from home during COVID-19 pandemic. Continuous data were presented in mean and standard deviation while categorical data were presented in percentage and frequency. The analysis of socio demographic background included gender, age, race, body mass index, education status, locality and total household income.

In addition, descriptive analysis was also used to obtained mean, standard deviation, frequency and percentage to assess social lifestyle among students learning from home during COVID-19 pandemic. Continuous data were presented in mean and standard deviation whereas categorical data were presented in percentage and frequency. The analysis of social lifestyle included time spent on sleeping, physical exercise and hobby, smoking or vaping activities and alcohol consumption.

3.7.1.2 Characteristics and Usage of Electronic Devices

Descriptive analysis was used to assess characteristics and usage of electronic devices, where data was presented in mean and standard deviation for continuous data and in frequency and percentage for categorical data. Analysis of characteristic and usage of electronic devices included type of display, input device, keyboard, chair, workstation, exposure time and characteristic of workstation.

3.7.1.3 Prevalence of Computer Vision Syndrome

Prevalence of computer vision syndrome was analyzed using descriptive analysis and presented in frequency and percentage. Prevalence of computer vision syndrome categorized as presence and absence of computer vision syndrome. Calculation method based on study described by Seguí et al. (2014) was used to determine the presence of computer vision syndrome.

The questionnaire measured frequency and intensity for each 16 items based on frequency and intensity rating scales of 0 to 2 (0 was "never"; 1 was "occasionally"; 2 was "often or always") and 1 to 2 (1 was "moderate"; 2 was "intense"), respectively. Scores of computer vision syndrome were calculated by multiplying frequency and intensity rating score for each item in the questionnaire. The result of frequency multiply by intensity for each item was then recoded (0 = 0; 1 or 2 = 1; 4 = 2).

The recoded score for each item was then calculated by summing the scores for 16 items in the questionnaire. If the total score is equal or bigger than 6 points, the student is considered to suffer computer vision syndrome.

3.7.2 Bivariate Analysis

Chi-Square test was used to determine the association between categorical variables with the prevalence of illness computer vision syndrome which were reported in the binary outcome. Fisher Exact test was used when there is violation of expected frequencies less than 5 in any of the 2x2 cells. Also, Pearson correlation test was used to statistically measure the relationship strengths and association between two variables denoted by correlation coefficient (r).

In this study, association between independent variables (socio demographic background, social lifestyle and characteristics and usage of electronic devices) and prevalence of computer vision syndrome were determined using these tests. Variables with p-value less than 0.05 were considered as associated significantly with computer vision syndrome.

3.7.3 Multivariate Analysis

Multiple logistic regression was used to predict the predictors of the prevalence of computer vision syndrome. This analysis was used to predict one dependent variable with a binary outcome from one or more study variables. Potential variables with p-value less than 0.25 were screen using simple logistic regression before included into multiple logistic regression. In multiple logistic regression, variables with p-value less than 0.05 were considered as the predictor of prevalence of computer vision syndrome.

3.8 Ethical Consideration

3.8.1 Universiti Putra Malaysia Approval

This research in the form of proposal has obtained approval from the Universiti Putra Malaysia Ethics Committee for Research Project Involving Human (JKEUPM) (approval letter as provided in Appendix F).

3.8.2 Individual Consent

The ethical aspects of this study included confidential information collected from the respondents. Identities and personal information of respondents given in this study were considered as private and confidential information and not exposed and shared to other researcher or any parties.

CHAPTER 4
RESULTS

From the 695 responses obtained, 38 data had to be excluded due to incomplete response. In total, 657 respondents with complete response were valid for this study.

4.1 Specific Objective 1: Sociodemographic Background and Social Lifestyle Among Students Learning from Home During the COVID-19 Pandemic.

The sociodemographic background and social lifestyle of the 657 students learning from home during COVID-19 pandemic were summarized in Table 4.1. Most participants were female (76.3%) with the mean age of 21.3 years old (SD = 2.0) and mean body mass index of 22.8 (SD = 7.7). The participants were mostly from Selangor (30.3%), followed by Johor (10.2%) and Perak (8.4%) and almost half of participants from urban communities (45.4%).

Majority of participants were Malay (84.6%) and most of participants were undergraduate students (84.5%). More than half of participants total household income were below RM4,850 (B40) (56.6%). Of the 657 students, 88.7% reported staying with family, while others reported staying with friends or alone. Mean average time spent by students on sleeping, physical exercise, and hobby away from electronic devices were 6.5 (SD = 1.4), 0.8 (SD = 0.9), and 1.7 (SD = 1.7) respectively. Of the 657, only 2.4% reported to smoke or vape and 0.9% consume alcohol.

Table 4.1: Sociodemographic background and social lifestyle among students learning from home during COVID-19 pandemic

Variables	Mean (SD)	Frequency (%)
Gender		
Male		156 (23.7)
Female		501 (76.3)
Age	21.3 (2.0)	
BMI (kg/m^2)	22.8 (7.7)	
State		
Perlis		6 (0.9)
Kedah		38 (5.8)
Penang		12 (1.8)
Perak		55 (8.4)
Kelantan		42 (6.4)
Terengganu		43 (6.5)
Pahang		49 (7.5)
Selangor		199 (30.3)
Kuala Lumpur		35 (5.4)
Putrajaya		30 (4.6)
Negeri Sembilan		30 (4.6)
Melaka		28 (4.3)
Johor		67 (10.2)
Sabah		15 (2.3)
Sarawak		29 (4.4)
Communities		
Urban		298 (45.4)
Suburban		220 (33.5)
Rural		139 (21.2)
Race		
Malay		556 (84.6)
Chinese		50 (7.6)
Indian		13 (2.0)
Others		38 (5.8)
Education status		
Foundation		13 (2.0)
Diploma		79 (12.0)
Undergraduate		555 (84.5)
Postgraduate		10 (1.5)
Total household income		
B40		372 (56.6)
M40		215 (32.7)
T20		70 (10.7)

Variables	Mean (SD)	Frequency (%)
Stay with family or friends or alone		
Family		583 (88.7)
Friends or alone		74 (11.3)
Average time of sleep	6.5 (1.4)	
Average time physical exercise	0.8 (0.9)	
Average time of hobby away from electronic devices	1.7 (1.7)	
Smoke or Vape		
Yes		16 (2.4)
No		641 (97.6)
Consume alcohol		
Yes		6 (0.9)
No		651 (99.1)

4.2 Characteristics and Usage of Electronic Devices Among Students Learning from Home During the COVID-19 Pandemic.

The usage of electronic devices for learning among students were summarized in Table 4.2. Most of the respondents used laptop (94.5%) as medium for learning from home although based on the response, they may concurrently use a different device. External mouse (76.9) and built-in keyboard (81.7) were the most commonly used input devices.

Majority (78.1%) of the students reported that they had a specific area for learning activities at home with 80.8% were using specific desk spending a mean of 4.7 hours (SD = 3.5) at the desk. The mean frequency of usage of electronic devices in a week was 6.3 hours (SD = 1.0), but 7.7 hours (SD = 3.2) in a day. Almost all the respondents (96.8%) reported taking break time with a mean duration of break at 1.2 (SD = 1.1).

Despite having a chair at their workstation (82.0%), 52.5% had no arm rest, 57.2% had non-adjustable lumbar support and 57.5% without castor or roller base at their chair. Among the respondents, less than half (44.3%) of them who also sat on chairs had their feet flat on the ground, not in contact with the back of the chair (43.2%) and with 45.7% of them had their neck bent forward or flexed.

More than half of the participants' vision were corrected with glasses (57.7%), followed by 40.2% with uncorrected vision, 1.7% corrected with contact lenses and 0.5% had surgery for their vision correction. Of the 657 respondents, 79.3% of them self-reported sufficient lighting or visual environment at workstation, followed by dim (15.1%) and too bright (2.3%).

Table 4.2: Characteristics and usage of electronic devices for learning among students learning from home during COVID-19 pandemic

Variable	Mean (SD)	Frequency (%)
Type of device	-	
Laptop		
Yes		621 (94.5)
No		36 (5.5)
Desktop		
Yes		29 (4.4)
No		628 (95.6)
Tablet		
Yes		84 (12.8)
No		573 (87.2)
Mobile phone		
Yes		520 (79.1)
No		137 (20.9)
Type of input device	-	
External mouse		
Yes		505 (76.9)
No		152 (23.1)
Built in touch pad		
Yes		240 (36.5)
No		417 (63.5)
Touch screen		
Yes		356 (54.2)
No		301 (45.8)
Type of keyboard	-	
External/separate keyboard		
Yes		150 (22.8)
No		507 (77.2)
Built in keyboard		
Yes		537 (81.7)
No		120 (18.3)
Touch screen		
Yes		292 (44.4)
No		365 (55.6)
Frequency usage (day per week)	6.3 (1.0)	
Duration of usage (per day)	7.7 (3.2)	
Break time (hours)	1.2 (1.1)	
Yes		636 (96.8)
No		21 (3.2)
Specific area/room for learning activities	-	
Yes		513 (78.1)
No		144 (21.9)

Variable	Mean (SD)	Frequency (%)
Type of workstation		
Specific desk for study (hours)	4.7 (3.5)	
Yes		531 (80.8)
No		126 (19.2)
Dining table (hours)	0.6 (1.5)	
Yes		136 (20.7)
No		521 (79.3)
Sofa (hours)	0.3 (1.0)	
Yes		102 (15.5)
No		555 (84.5)
Floor (hours)	0.8 (1.7)	
Yes		197 (30.0)
No		460 (70.0)
Bed (hours)	1.2 (1.9)	
Yes		277 (42.2)
No		380 (57.8)
Others (hours)	0.1 (0.9)	
Yes		24 (3.7)
No		633 (96.3)
Chair	-	
Arm rest		
Yes-adjustable		54 (8.2)
Yes-not adjustable		140 (21.3)
No		345 (52.5)
Not using a chair		118 (18.0)
Lumbar support		
Yes-adjustable		121 (18.4)
Yes-not adjustable		376 (57.2)
No		42 (6.4)
Not using a chair		118 (18.0)
Pan depth adjustable		
Yes		65 (9.9)
No		474 (72.1)
Not using a chair		118(18.0)
Chair height adjustable		
Yes		143 (21.8)
No		396 (60.3)
Not using a chair		118 (18.0)
Leg condition when sitting on chair		
Leg hanging		40 (6.1)
Feet flat on ground		291 (44.3)
Leg folding on chair		208 (31.7)
Not using a chair		118 (18.0)
Castor or roller		
Yes		161 (24.5)
No		378 (57.5)
Not using chair		118 (18.0)

Variable	Mean (SD)	Frequency (%)
Chair		
Back in contact with back of chair		
Yes		255 (38.8)
No		284 (43.2)
Not using a chair		118 (18.0)
Neck bent forward (flexed)		
Yes		300 (45.7)
No		239 (36.4)
Not using a chair		118 (18.0)
Neck bent backwards (extended)		
Yes		95 (14.5)
No		444 (67.6)
Not using a chair		118 (18.0)
Upper body twisted sideways		
Yes		168 (25.6)
No		371 (56.5)
Not using a chair		118 (18.0)
Neck twisted or bent sideways		
Yes		137 (20.9)
No		402 (61.2)
Not using a chair		118 (18.0)
Visual Environment	-	
Dark		10 (1.5)
Dim		99 (15.1)
Too bright		15 (2.3)
Glaring		12 (1.8)
Sufficient		521 (79.3)
Vision corrected	-	
No vision corrected		264 (40.2)
Corrected with contact lenses		11 (1.7)
Corrected with glasses		379 (57.7)
Corrected with surgery		2 (0.5)

n = 657

4.3 Prevalence of Computer Vision Syndrome Among Students Learning from Home During the COVID-19 Pandemic.

Table 4.3 summarized the symptoms as well as the prevalence of computer vision syndrome among respondents in this study. Based on the results, prevalence of computer vision syndrome among students was 71.2% (n = 468). Breaking the data down into individual symptoms of computer vision syndrome, the most frequent symptoms reported were headache (n = 556, 84.6%).

This was followed by the symptoms of the eyes being itchy (n = 421, 64%), heavy eyelids (n = 415, 63.1%), feeling that eyesight is worsening (n = 408, 62.1%), increased sensitivity to light (n = 396, 60.2%), burning (n = 384, 58.4%), blurred vision (n = 375, 57.0 %), tearing (n = 370, 56.3%) and feeling of a foreign body in the eye (n = 332, 50.3%), all of which by more than half of the respondents in this study.

Table 4.3: Prevalence of computer vision syndrome and their symptoms among students learning from home during COVID-19 pandemic

	Frequency (%)
Symptoms	
Eye burning	384 (58.4)
Eye itching	421 (64.0)
Feeling of a foreign body	332 (50.5)
Tearing	370 (56.3)
Excessive blinking	307 (46.7)
Eye redness	287 (43.6)
Eye pain	297 (45.2)
Heavy eyelids	415 (63.1)
Eye dryness	323 (49.1)
Blurred vision	375 (57.0)
Double vision	180 (27.3)
Difficulty focusing for near vision	230 (35.0)
Increased sensitivity to light	396 (60.2)
Colored halos around objects	145 (22.0)
Feeling that eyesight is worsening	408 (62.1)
Headache	556 (84.6)
Computer vision syndrome	
Yes	189 (28.8)
No	468 (71.2)

4.4 Association between Socio Demographic Background, Social Lifestyle, Characteristics, Usage of Electronic Devices, Chairs Characteristics, Body Posture and Workstation Lighting Environment with Computer Vision Syndrome Among Students Learning from Home During COVID-19 Pandemic.

Using the scores for computer vision syndrome as continuous data, the correlational analysis in Table 4.4 showed significant relationship between the score of computer vision syndrome with duration of physical exercise ($r = 0.095$, $p = 0.015$), time spent on hobby ($r = 0.089$, $p = 0.022$) and time spent on floor as learning workstation ($r = -0.122$, $p = 0.002$). No significant relationships were found between the prevalence of computer vision syndrome with socio demographic background (age, body mass index and duration of sleep) and characteristics and usage of electronic devices that include exposure time (time spent specific desk, dining table, sofa, bed and others as learning workstation, frequency usage, duration usage and duration break time).

Categorizing the score for CVS as categorical data, the chi-square analysis as provided in Table 4.5 showed that there were significant associations between the prevalence of computer vision syndrome with gender ($\chi^2 = 9.382$, $p = 0.002$), respondents who use mobile phone for learning activities ($\chi^2 = 6.044$, $p = 0.015$), respondents who use the floor as a learning workstation ($\chi^2 = 8.689$, $p = 0.003$), respondents who use the bed as a learning workstation ($\chi^2 = 4.159$, $p = 0.045$), condition of the student's leg while sitting on chair at the learning workstation ($\chi^2 = 8.173$, $p = 0.042$), upper body of the respondents twisted sideways while using electronic devices ($\chi^2 = 10.248$, $p = 0.006$), neck of the respondents twisted sideways while using electronic devices ($\chi^2 = 7.499$, $p = 0.023$) and students with vision corrected ($\chi^2 = 8.988$, $p = 0.03$). No significant association were found between the prevalence of computer vision syndrome with all other variables tested.

Table 4.4: Association between the prevalence of computer vision syndrome with categorical variables

Variables	CVS, Frequency (%)		χ^2 (df)	p-value
	No	Yes		
Gender			9.382 (1)	**0.002***
Male	60 (9.1)	96 (14.6)		
Female	129 (19.6)	372 (56.6)		
Communities			-[b]	0.080
Urban	95 (14.5)	203 (30.9)		
Suburban	51 (7.8)	169 (25.7)		
Rural	43 (6.5)	96 (14.6)		
Race			-[b]	0.159
Malay	157 (23.9)	399 (60.7)		
Chinese	19 (2.9)	31 (4.7)		
Indian	1 (0.2)	12 (1.8)		
Others	12 (1.8)	26 (4.0)		
Education status			-[b]	0.409
Foundation	4 (0.6)	9 (1.4)		
Diploma	25 (3.8)	54 (8.2)		
Undergraduate	155 (23.6)	400 (60.9)		
Postgraduate	5 (0.8)	5 (0.8)		
Total household income			0.159 (2)	0.912
B40	105 (16.0)	267 (40.6)		
M40	64 (9.7)	151 (23.0)		
T20	20 (3.0)	50 (7.6)		
Stay with family, friends or alone			0.123 (1)	0.786
Family	169 (25.7)	414 (63.0)		
Friends or alone	20 (3.0)	54 (8.2)		
Smoke or Vape			-[b]	0.576
Yes	6 (0.9)	10 (1.5)		
No	183 (27.9)	458 (69.7)		
Consume alcohol			-[b]	1.000
Yes	2 (0.3)	4 (0.6)		
No	187 (28.5)	464 (70.6)		
Type of device				
Laptop			0.18 (1)	1.000
Yes	179 (27.2)	442 (67.3)		
No	10 (1.5)	26 (4.0)		
Desktop			0.966 (1)	0.405
Yes	6 (0.9)	23 (3.5)		
No	183 (27.9)	445 (67.7)		
Tablet			0.900 (1)	0.798
Yes	23 (3.5)	61 (9.3)		
No	166 (25.3)	407 (61.9)		

Variables	CVS, Frequency (%)		χ^2 (df)	p-value
	No	Yes		
Mobile phone			6.044 (1)	**0.015***
Yes	138 (21.0)	382 (58.1)		
No	51 (7.8)	86 (13.1)		
Type of input device				
External mouse			0.068 (1)	0.838
Yes	144 (21.9)	361 (54.9)		
No	45 (6.8)	107 (16.3)		
Built in touch pad			0.000 (1)	1.000
Yes	69 (10.5)	171 (26.0)		
No	120 (18.3)	297 (45.2)		
Touch screen			1.643 (1)	0.226
Yes	95 (14.5)	261 (39.7)		
No	94 (14.3)	207 (31.5)		
Type of keyboard				
External/separate keyboard			0.056 (1)	0.838
Yes	42 (6.4)	108 (16.4)		
No	147 (22.4)	360 (54.8)		
Built in keyboard			0.109 (1)	0.824
Yes	153 (23.3)	354 (58.4)		
No	36 (5.5)	84 (12.8)		
Touch screen			3.008 (1)	0.099
Yes	74 (11.3)	218 (33.2)		
No	115 (17.5)	250 (38.1)		
Break time	184 (28.0)	452 (68.8)	0.260 (1)	0.641
Yes	5 (0.8)	16 (2.4)		
No				
Specific area for learning activities			0.255(1)	0.677
Yes	150 (22.8)	363 (55.3)		
No	39 (5.9)	105 (16.0)		
Type of workstation				
Specific desk for study			0.074 (1)	0.827
Yes	154 (23.4)	377 (57.4)		
No	35 (5.3)	91 (13.9)		
Dining table			0.204 (1)	0.672
Yes	37 (5.6)	99 (15.1)		
No	152 (23.1)	369 (56.2)		
Sofa			3.053 (1)	0.095
Yes	22 (3.3)	80 (12.2)		
No	167 (25.4)	388 (59.1)		
Floor			8.689 (1)	**0.003***
Yes	41 (6.2)	156 (23.7)		
No	148 (22.5)	312 (47.5)		
Bed			4.159 (1)	**0.045***
Yes	68 (10.4)	209 (31.8)		
No	121 (18.4)	259 (39.4)		

Variables	CVS, Frequency (%)		χ^2 (df)	p-value
	No	Yes		
Others			0.173 (1)	0.820
Yes	6 (0.9)	18 (2.7)		
No	183 (27.9)	450 (68.5)		
Chair				
Arm rest			2.905 (3)	0.410
Yes-adjustable	20 (3.0)	34 (5.2)		
Yes-not adjustable	36 (5.5)	104 (15.8)		
No	102 (15.5)	243 (37.0)		
Not using chair	31(4.7)	87(13.2)		
Lumbar support			0.562 (3)	0.908
Yes-adjustable	37 (5.6)	84 (12.8)		
Yes-not adjustable	109 (16.6)	267 (40.6)		
No	12 (1.8)	30 (4.6)		
Not using chair	31(4.7)	87(13.2)		
Pan depth adjustable			1.178 (2)	0.565
Yes	22 (3.3)	43 (6.5)		
No	136 (20.7)	338 (51.4)		
Not using chair	31(4.7)	87(13.2)		
Height adjustability			1.637 (2)	0.443
Yes	47 (7.2)	96 (14.6)		
No	111 (16.9)	285 (43.4)		
Not using chair	31(4.7)	87(13.2)		
Castor or roller			0.777 (2)	0.691
Yes	50 (7.6)	111 (16.9)		
No	108 (16.4)	270 (41.1)		
Not using chair	31(4.7)	87(13.2)		
Body posture when using chairs				
Leg condition			8.173 (3)	**0.042***
Feet flat on ground	99 (15.1)	192 (29.2)		
Leg hanging	12 (1.8)	28 (4.3)		
Leg folding on chair	97 (7.2)	161 (24.5)		
Not using chair	31(4.7)	87(13.2)		
Back lean on backrest			0.712 (2)	0.698
Yes	72 (11.0)	183 (27.9)		
No	86 (13.1)	198 (30.1)		
Not using chair	31(4.7)	87(13.2)		
Neck bent forward			1.333 (2)	0.516
Yes	75 (11.4)	164 (25.0)		
No	83 (12.6)	217 (33.0)		
Not using chair	31(4.7)	87(13.2)		
Neck bent backwards			2.570 (2)	0.278
Yes	136 (20.7)	308 (46.9)		
No	22 (3.3)	73 (11.1)		
Not using chair	31(4.7)	87(13.2)		

Variables	CVS, Frequency (%)		χ^2 (df)	p-value
	No	Yes		
Upper body twisted sideways			10.248 (2)	**0.006***
Yes	124 (18.9)	247 (37.6)		
No	34 (5.2)	134 (20.4)		
Not using chair	31(4.7)	87(13.2)		
Neck twisted sideways			7.499 (2)	**0.023***
Yes	130 (19.8)	272 (41.4)		
No	28 (4.3)	109 (16.6)		
Not using chair	31(4.7)	87(13.2)		
Visual environment			-[b]	0.119
Dark	5 (0.8)	5 (0.8)		
Dim	20 (3.0)	79 (12.0)		
Too bright	4 (0.6)	11 (1.7)		
Glaring	2 (0.3)	10 (1.5)		
Sufficient	158 (24.0)	363 (55.3)		
Vision corrected			8.988 (1)	**0.003***
Yes	96 (14.6)	297 (45.2)		
No	93 (14.2)	171 (26.0)		

[b] Fisher Exact test was used.
*p-value significant at <0.05

Table 4.5: Correlation between the computer vision syndrome score with continuous variables

	Pearson correlation	P value
Age * CVS	0.002	0.954
BMI * CVS	-0.032	0.407
Duration of sleep * CVS	0.060	0.122
Duration of physical exercise * CVS	0.095	**0.015***
Time spent on hobby * CVS	0.089	**0.022***
Time spent on specific desk * CVS	-0.016	0.673
Time spent on dining table * CVS	-0.002	0.965
Time spent on sofa * CVS	-0.037	0.347
Time spent on floor * CVS	-0.122	**0.002***
Time spent on bed * CVS	-0.044	0.265
Time spent on others workstation * CVS	<0.001	0.991
Frequency of usage in a week * CVS	-0.047	0.234
Duration of usage in a day * CVS	-0.072	0.066
Duration of break time * CVS	0.049	0.208

*p-value significant at <0.05

4.5 Predictors of Prevalence of Computer Vision Syndrome Among Students Learning from Home During COVID-19 Pandemic.

Table 4.6 shows list of predictors associated with the prevalence of computer vision syndrome. Using simple logistic regression, gender, average time of physical exercise and hobby away from electronic devices, use of mobile devices for learning activities, use of floor and bed as learning workstation, leg condition when sitting on chair, upper body and neck twisted sideways while learning using electronic devices, visual environment at workstation and respondents with vision correction were found significantly associated with the prevalence of computer vision syndrome among respondents learning from home.

Being female, using mobile phone, working on floor and bed as workstation presents significantly higher odds of reporting computer vision syndrome compared to the other counterpart options with an odd ratio of 1.802 (95% CI = 1.235-2.635, p = 0.002), 1.642 (95% CI = 1.103-2.442, p = 0.014), 1.805 (95% CI = 1.215-2.681, p = 0.003) and 1.436 (95% CI = 1.013-2.035, p = 0.042) respectively. In terms of postures, the odd ratio of reporting CVS were also higher for those who sat with leg folded on chair (OR = 1.766, 95% CI = 1.178-2.649, p = 0.006), twisted upper body (OR = 1.979, 95% CI = 1.282-2.053, p = 0.002 and neck twisted sideways while learning using electronic devices (OR = 1.861, 95% CI = 1.169-2.962, p = 0.009).

Respondents with dim visual environment at their workstation reported higher odds of having computer vision syndrome than those who with sufficient visual environment at their workstation (OR = 1.719, 95% CI = 1.017-2.906, p = 0.043) which was similarly found among those who wore glasses for vision correction (OR = 1.746, 95% CI = 1.236-2.468, p = 0.002).

Table 4.6: List of predictors associated with computer vision syndrome among students learning from home

Variable	Crude OR	β	SE	Wald	95% CI (Lower, Upper)	p-value
Gender						
Male	1.000					
Female	1.802	0.589	0.194	9.248	1.235, 2.635	**0.002***
Age	0.998	-0.002	0.043	0.003	0.917, 1.085	0.954
BMI (kg/m^2)	1.012	0.012	0.014	0.674	0.984, 1.040	0.412
Communities						
Rural	1.000					
Urban	0.957	-0.044	0.222	0.039	0.620, 1.478	0.843
Suburban	1.844	0.395	0.243	2.635	0.921, 2.391	0.105
Race						
Malay	1.000					
Chinese	0.642	-0.443	0.306	2.095	0.352, 1.170	0.148
Indian	4.722	1.552	1.045	2.206	0.609, 3.617	0.137
Others	0.853	-0.160	0.361	0.195	0.420, 1.731	0.659
Education status						
Foundation	1.000					
Diploma	0.960	-0.041	0.648	0.004	0.270, 3.417	0.950
Undergraduate	1.147	0.137	0.608	0.051	0.348, 23.779	0.822
Postgraduate	0.444	-0.811	0.872	0.864	0.080, 2.457	0.353
Total household income						
T20	1.000					
B40	1.017	0.017	0.289	0.003	0.578, 1.791	0.953
M40	0.944	-0.058	0.304	0.036	0.520, 1.712	0.849

Variable	Crude OR	β	SE	Wald	95% CI (Lower, Upper)	p-value
Stay with friends or alone or family						
Friends or alone	1.000					
Family	0.907	-0.097	0.277	0.123	0.527, 1.562	0.726
Average time of sleep	0.911	-0.094	0.061	2.381	0.809, 1.026	0.123
Average time of physical exercise	0.795	-0.229	0.097	5.618	0.658, 0.961	**0.018***
Average time of hobby away from electronic devices	0.898	-0.108	0.048	5.050	0.817, 0.986	**0.025***
Smoke or Vape						
No	1.000					
Yes	0.666	-0.407	0.524	0.603	0.239, 1.859	0.438
Consume alcohol						
No	1.000					
Yes	0.806	-0.216	0.870	0.061	0.146, 4.438	0.804
Specific area for learning activities						
No	1.000					
Yes	0.899	-0.107	0.211	0.255	0.594, 1.360	0.614
Type of device						
Laptop						
No	1.000					
Yes	0.956	-0.052	0.383	0.018	0.449, 2.010	0.893
Desktop						
No	1.000					
Yes	1.576	0.455	0.467	0.951	0.631, 3.935	0.329

Variable	Crude OR	β	SE	Wald	95% CI (Lower, Upper)	p-value
Tablet						
No	1.000					
Yes	1.082	0.079	0.261	0.900	0.648, 1.806	0.764
Mobile phone						
No	1.000					
Yes	1.642	0.496	0.203	5.977	1.103, 2.442	**0.014***
Type of input device						
External mouse						
No	1.000					
Yes	1.054	0.053	0.203	0.068	0.708, 1.570	0.795
Built in touch pad						
No	1.000					
Yes	1.001	0.001	0.179	0.000	00.705, 1.422	0.994
Touch screen						
No	1.000					
Yes	1.248	0.221	0.173	1.641	0.889, 1.750	0.200
Type of keyboard						
External keyboard						
No	1.000					
Yes	1.050	0.049	0.207	0.056	0.700, 1.574	0.813
Built in keyboard						
No	1.000					
Yes	1.076	0.073	0.221	0.109	0.698, 1.659	0.741
Touch screen						
No	1.000					
Yes	1.355	0.304	0.175	2.999	0.961, 1.911	0.083

Variable	Crude OR	β	SE	Wald	95% CI (Lower, Upper)	p-value
Frequency usage (day per week)	1.104	0.099	0.083	1.416	0.938, 1.298	0.234
Duration usage (per day)	1.052	0.051	0.028	3.366	0.997, 1.111	0.067
Break time		-0.264	0.520	0.259		0.611
No	1.000					
Yes	0.768				0.277, 2.126	
Duration of break	0.910	-0.094	0.075	1.572	0.786, 1.054	0.210
Type of workstation						
Specific desk						
No	1.000					
Yes	0.942	-0.060	0.221	0.074	0.611, 1.451	0.785
Dining table						
No	1.000					
Yes	1.102	0.097	0.215	0.204	0.723, 1.681	0.652
Sofa						
No	1.000					
Yes	1.565	0.448	0.258	3.017	0.944, 2.595	0.082
Floor						
No	1.000					
Yes	1.805	0.590	0.202	8.554	1.215, 2.681	**0.003***
Bed						
No	1.000					
Yes	1.436	0.362	0.178	4.140	1.013, 2.035	**0.042***
Others						
No	1.000					
Yes	1.220	0.199	0.479	0.172	0.477, 3.122	0.678

Variable	Crude OR	β	SE	Wald	95% CI (Lower, Upper)	p-value
Time spent on each workstation						
Specific desk	1.010	0.010	0.025	0.178	0.963, 1.060	0.673
Dining table	1.002	0.002	0.056	0.002	0.898, 1.120	0.965
Sofa	1.093	0.089	0.095	0.876	0.907, 1.318	0.349
Floor	1.277	0.204	0.068	9.125	0.074, 1.401	**0.003***
Bed	1.055	0.053	0.048	1.240	0.960, 1.158	0.265
Others	1.001	0.001	0.100	0.000	0.824, 1.27	0.991
Chair						
Arm rest						
No	1.000					
Yes-adjustable	0.714	-0.337	0.306	1.220	0.392, 1.299	0.121
Yes-not adjustable	1.213	0.193	0.227	0.724	0.778, 1.890	0.269
Lumbar support						
No	1.000					
Yes-adjustable	0.908	-0.096	0.394	0.060	0.419, 1.967	0.739
Yes-not adjustable	0.980	-0.020	0.360	0.003	0.484, 1.984	0.807
Pan depth adjustable						
No	1.000					
Yes	0.786	-0.240	0.281	0.730	0.453, 1.364	0.393
Height adjustability						
No	1.000					
Yes	0.796	-0.229	0.210	1.184	0.527, 1.201	0.277
Castor or roller						
No	1.000					
Yes	0.888	-0.119	0.205	0.336	0.594, 1.327	0.562

Variable	Crude OR	β	SE	Wald	95% CI (Lower, Upper)	p-value
Body posture when using chair						
Leg condition						
Feet flat on ground	1.000					
Leg hanging	1.203	0.185	0.367	0.255	0.587, 2.468	0.614
Leg folding on chair	1.766	0.569	0.207	7.562	1.178, 2.649	**0.006***
Back against chair						
No	1.000					
Yes	1.104	0.099	0.190	0.271	0.761, 1.602	0.602
Neck bent forward						
No	1.000					
Yes	1.196	0.179	0.190	0.885	0.824, 1.735	0.347
Neck bent backwards						
No	1.000					
Yes	1.465	0.382	0.264	2.092	0.873, 2.459	0.148
Neck twisted sideways						
No	1.000					
Yes	1.861	0.621	0.237	6.852	1.169, 2.962	**0.009***
Upper body twisted sideways						
No	1.000					
Yes	1.979	0.682	0.221	9.505	1.282, 3.053	**0.002***
Visual environment						
Sufficient	1.000					
Dark	0.435	-0.832	0.640	1.690	0.124, 1.525	0.193
Dim	1.719	0.542	0.268	4.093	1.017, 2.906	**0.043***
Too bright	1.197	0.180	0.592	0.092	0.375, 3.816	0.761
Glaring	2.176	0.778	0.780	0.993	0.471, 10.047	0.319

Variable	Crude OR	β	SE	Wald	95% CI (Lower, Upper)	p-value
Vision corrected						
No vision corrected	1.000					
Contact lenses	0.952	-0.049	0.640	0.006	0.272, 3.336	0.938
Glasses	1.746	0.558	0.177	9.973	1.236, 2.468	**0.002***
Surgery	0.272	-1.302	1.232	1.118	0.024, 3.039	0.290

OR = Odds ratio.
SE = Standard error.
CI = Confidence interval.
*p-value significant at <0.05

Based on simple logistic regression, mobile phone, touch screen input device, touch screen keyboard, sofa, floor and bed as learning workstation, chair with non-adjustable arm rest, leg folding on chair at learning workstation, neck bent backwards, upper body and neck twisted sideways while learning, frequency and duration of usage of electronic devices and duration of break and dark and dim visual environment at learning workstation with p-value <0.25 were included in multiple logistic regression. Table 4.9 shows the predictors associated with prevalence of computer vision syndrome among students learning from home.

The results of multiple logistic regression show that students who had vision correction with glasses have higher odds of having computer vision syndrome compared to those without vision correction (OR = 1.747, 95% CI = 1.202-2.539, p = 0.003). Also, students who spent time on floor as learning workstation have high odds of having computer vision syndrome (OR = 1.208, 95% CI = 1.055-1.383, p = 0.006). Students who upper body twisted sideways while learning using electronic devices have higher odds of having computer vision syndrome compared to those who sit with the body centered with the monitor or screen of electronic devices while learning (OR = 1.827, 95% CI = 1.171-2.851, p = 0.008).

Table 4.7: Predictors associated with computer vision syndrome among students learning from home during COVID-19 pandemic, multiple logistic regression

Variable	Adjusted OR	Adjusted β	SE	Wald	95% CI (Lower, Upper)	p-value
Vision Correction						
No	1.000					
Corrected with glasses	1.747	0.558	0.191	8.459	1.202, 2.539	**0.003***
Corrected with contact lenses	1.735	0.551	0.679	0.658	0.458, 6.566	0.417
Corrected with surgery	0.345	-1.065	1.333	0.638	0.025, 4.705	0.425
Time spent on floor	1.208	0.189	0.069	7.519	1.055, 1.383	**0.006***
Upper body twisted sideways						
No	1.000					
Yes	1.827	0.603	0.227	7.054	1.171, 2.851	**0.008***

Model assumptions are met. There was no interaction and multicollinearity problems. Omnibust test was statistically significant (χ^2 = 31.323, df = 4, p<0.001). Cox & Snell R^2 = 0.047. Negelkerke R^2 = 0.067. Overall percentage = 71.2%. The Hosmer-Lemeshow goodness of fitness test shows the model was fit (χ^2 = 9.208, df = 6, p = 0.162). Area under ROC curve = 0.563 (95% CI: 0.515-0.612, p = 0.011)
Variable selection method = Backward (Conditional)
OR = Odds ratio
SE = Standard error
CI = Confidence interval
*p-value significant at <0.05

CHAPTER 5
DISCUSSION

In this study, the prevalence of computer vision syndrome (CVS) was considerably high (71.2%). While Huda and Muhammad (2014) found the prevalence to be 63.0% from a study conducted in a public university in Malaysia (63%), results by Reddy et al. (2013) were astounding 89.9% among students in Malaysia which pale in comparison to 95.0% in a study conducted by Abudawood et al. (2020) in university in Jeddah, Saudi Arabia, among undergraduate medical students. The disparities of prevalence of CVS reported between the different studies could be justified by the study population, geographical-climate factors as well as temporal factor.

Specifically, it should be noted that the previous studies were conducted among respondents in setting dissimilar to the one in this study. As the focus of this study was to investigate the situation of students learning from home corresponding to the COVID-19 pandemic, it is suspected that the students may be exposed to the usage of electronic devices at much prolonged period as compared to the previous study, case-in-point, conventional physical in-person attendance of learning activities not limited to classroom lectures but also outdoor face-to-face discussion and activities.

However, it appears that regardless or not whether the respondents were learning from home or otherwise, the prevalence of CVS remains high. Due to the non-standardized tools and methodologies employed between these studies, direct comparison cannot be assured where several previous studies reported only a number of symptoms while some others used a different instrument. It would be noteworthy based on the results in this study that most respondents who were students learning from home self-reported significant concerns in terms of the eyes' symptoms.

In determining the potential risk factors associated with the prevalence of computer vision syndrome, the result for gender in this study had similar findings with several previous studies despite the differences of study population; operators of call center in Sao Paulo, Brazil (Costa at al., 2012); among medical and engineering students in Chennai (Muthunarayanan et al., 2013) which reported high risk of CVS among male,

whereas study by Zairina and Suhaila (2011) reported that female had significantly higher risk (OR = 2.69) for computer vision syndrome. This study, however, did not find gender to be a significant predictor for the prevalence of CVS.

In relation to the social lifestyle, the CVS score were shown to be correlated with the mean time spent on physical exercise as well as hobby. However, the strength of the positive relationship was relatively weak (being <0.1) where they were not found to be significant predictors of CVS. Supporting these findings, a survey done in Malaysia revealed that time spent on exercise by Malaysian adults were lower than minimum hours recommended by most fitness expert and the internet and smartphone usage act as barrier that preventing Malaysians from getting enough exercise (AIA Healthy Living Index, 2016).

In the viewpoint of researcher, lack of time spent on physical exercise and hobby away from electronic devices cause by higher duration of time spent on electronic device with respondents' mean duration of usage of electronic devices in a day was 7.7 hours that can increase risk of developing symptoms of CVS. This was a sharp contrast to the 0.8 hour and 1.7 hours a day spent on exercise and hobby away from electronic devices.

Between the different electronic devices used, the results of this study point specifically to the significant association between the usage of mobile phone used for learning activities with CVS. Findings from previous study which reported significant association between other electronic devices, specifically the usage of laptop for learning activities with the prevalence of computer vision syndrome were not found in this study among students and unfortunately, this study unable to find the inference to this finding due to the limited data provided on exposure time particularly for each type of electronic devices used by the students.

Further to that, it appeared that the usage of different type of input device and keyboard with computer vision syndrome. Based on the theoretical background, it doesn't appear that usage of input devices could affect one's vision. In terms of workstations, while floor and bed as learning workstation were found to be associated significantly with the prevalence of CVS among respondents in this study, only duration spent on

floor as workstation were a significant predictor of CVS where for each one (1) hour spent on the floor, the odd of developing CVS increases by 1.208 times.

Although it is expected that using floor and bed as workstation for learning activities primarily present the risk of ergonomics; awkward posture that could be potentially static or prolonged, the findings in this study could be due to additional strain on muscles of the eyes where in awkward position, the screen may be either too far, too close or at angle or position that creates glare or insufficient lighting in such way that affect the vision.

A correct posture for reading, screen viewing, or typing are arm's length away from screen with eye at same level with the screen while sitting up straight with supported lower back (Mashige et al., 2013) and screen located straight in front of the face instead of the to any sides (Shilpa, n.d.). In that regard, Optical Express (2019) commented that reading while lying down associated with risk developing eye symptoms such as fatigue, discomfort, blurred vision, headache, and sometimes double vision. This is expected to be worse for reading from display of electronic devices due to the dynamic factors of font, lighting, refresh rate, and many other factors.

It was also intriguing that for those who used a chair but had neck and upper body twisted sideway were found to be associated with the prevalence of CVS in this study but only the twisted upper body were a significant predictor. It appeared that postures or at least one of them in this study indeed affect the prevalence of CVS with almost twice the higher odd (OR = 1.827) although there was no clear explanation. Besides off-centered screen or monitor, it is expected that the sideway twisted upper body and neck at learning workstation could be simply due to poor knowledge, attitude, or practices.

While this study was unable to find an association between exposure time of electronic devices with the prevalence of CVS, several previous studies reported (Yan et al, 2008) such association where Dessie et al. (2018) and Reddy et al. (2013) both revealed that usage of electronic devices for more than 4.6 hour in a day and continuously for 2 hours in respective study was found significantly associated with CVS. It was also further found that students who had vision correction with glasses were at higher risk;

almost twice the odd (OR = 1.747) compared to those without vision correction which was being expected.

Although it was unfortunate that it wasn't probed in this study, a controlled experiment conducted by Harvey (2006) reported statistically significant results with eyestrain increases post-test where they investigated the effectiveness of commercially available computer glasses in reducing CVS. A systematic review had also reported various ophthalmological condition of the eyes; refractive errors showed increase of symptoms reported. In the case of glasses or spectacle wearer, under- as well as over-correction can also influence CVS.

CHAPTER 6
CONCLUSION

6.1 Conclusion

The results of this study showed that computer vision syndrome is still a concern with considerably high prevalence as previous study at 71.2% although it was postulated that the COVID-19 pandemic would increase interaction time of students with the display of electronic devices with the learning from home alternative. In terms of socio demographic background, gender was found to be associated with computer vision syndrome among students learning from home while time spent on physical exercise and hobby away from electronic devices under social lifestyle was found associated with the prevalence of computer vision syndrome.

Considering the various ergonomics aspects, usage of mobile phone, floor (including time spent on floor) as workstation, those seated on chair with neck and upper body twisted sideway during learning activities at home were found to be associated/correlated with computer vision syndrome. From the variable which were found significantly associated/correlated, only time spent on floor, wore glasses and sat with upper body twisted sideway were predictors which odds of prevalence of CVS increases almost two-fold for the latter risk factors.

6.2 Study Limitation and Strength

A significant challenge in this study was the limited time provided for data collection. Considering the online survey – convenience sampling employed, the one-month time period for data collection would have been deemed sufficient although it was hoped that the study could have achieve more responses relative to the university's students available throughout Malaysia. With regular reminders and at higher frequencies, it was expected that the study may be able to recruit more respondents.

Unfortunately, there was no external physical assessment designed for this study to confirm the sign and symptoms of computer vision syndrome self-reported by

respondents. Regardless of the limitation imposed by COVID-19, it would have been impossible to carry out a face-to-face physical assessment considering the costs, time, and human resources particularly specialist or expertise to be involved which would be required nationwide.

Similarly for ergonomics aspects, it was not possible for a quantitative assessment to be conducted for each of the respondents where the observation would be labour intensive and time consuming. Although the usage of electronic devices could be self-reported, postural assessment and the learning environment of each respondents had to use not only rapid but also simple questions in order to encourage responses using the questionnaire. Nevertheless, a quantitative measurement could have provided a more specific and accurate accounts on the practice and condition of each respondent's home workstation when engaging in online learning using electronic devices.

To enhance the validity of the results and obtained better data-description despite the limitations, the online questionnaire was validated through validity tests and pre-tested, for reliability before the actual data collection was conducted. Validity test was conducted by an expert in the field of ergonomics to evaluate the appropriateness and relevancy of the questionnaire and pre-test was carried out on the targeted respondents and the reliability test carried out show that the questionnaire was reliable and acceptable.

As such, it has to be acknowledged that there was various assumption which had to be made in compensation of the limitations. Specifically, the question on vision only considered the presence of refractive errors but not the severity or any other ophthalmologic condition. Besides that, the questions on input devices, types of workstations and time spent on them, chairs characteristics and subjective lighting perception assumed that certain options within the questionnaire would have resulted in sign or symptoms of CVS.

6.3 Study Recommendation

Based on the findings of this study, the following recommendations are made in order to reduce the prevalence of computer vision syndrome among the respondents. It is primarily suggested that the respondents are provided with awareness and knowledge (educational) resources which can be in various forms of material which includes poster, brochures, short articles, webinar, seminar, forum, workshops, apps, or any other activities which enhances learning.

The material should focus on the symptoms of computer vision syndromes, the long-term effects and implications, steps, set-up and initiatives to improve their learning workstation condition at home to reduce the occurrence of computer vision syndrome, usage of a proper learning workstation, correct posture during usage of electronic devices, advices of using the bed, floor and other such workstation which had similar risk, self-help for improvements, usage time limit, etc.

In terms of improvement on the scope of research, it is recommended that the future study includes as much as possible usage of a quantitative assessment tool which can also be used by respondents including a much more extensive consideration of various aspects of the study which includes but not limited to the tracking of duration of usage for electronic devices, workstation as well as any other factors which could affect or be affected. This would include the productivities, the effectiveness of learning from home, musculoskeletal discomforts, etc. which can also be extended to other group of respondents including students in primary and secondary schools to have a wider reach.

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APPENDIX A

SOCIO DEMOGRAPHIC QUESTIONNAIRE

This section has 11 questions. Please answers all questions.

1. What is your gender?
   - Male
   - Female

2. What is your age?

   _____

3. What is your height (cm)?

   _____

4. What is your weight (kg)?

   _____

5. In which state do you currently living while studying from home?
   - Perlis
   - Kedah
   - Penang
   - Perak
   - Kelantan
   - Terengganu
   - Pahang
   - Selangor
   - Kuala Lumpur
   - Putrajaya
   - Negeri Sembilan
   - Melaka
   - Johor
   - Sabah
   - Sarawak

6. What is type of communities are you currently living during learning from home?
   - Urban
   - Suburban
   - Rural

7. What is your race?
   - Malay
   - Chinese
   - Indian
   - Others
     Please specify _____

8. What is your current education status? (Please specify your course).

- Foundation (under university programs) _____
- Diploma (under university programs) _____
- Bachelor's degree _____
- Master's degree _____
- Doctoral degree _____

9. How much is your total household income?
    - Below RM4,850 (B40)
    - RM4,850 – RM10,959 (M40)
    - Above RM10,959 (T20)

10. Do you currently stay with family or friends during learning from home?
    - Staying with family
    - Staying with friends

11. Do you have specific area or room to do learning activities during learning from home?
    - Yes
    - No

APPENDIX B

SOCIAL LIFESTYLE QUESTIONNAIRE

This section has 5 questions. Please answers all questions.

1. State the average time you spend on sleep per day?
   Hour _____
   Minute _____

2. State the average time you spend on physical exercise (i.e.: jogging, running, cycling, etc) per day.
   Hour_____
   Minute _____

3. State the average time you spend on your hobby that away from electronic devices (i.e.: gardening, reading book, knitting, etc) per day.
   Hour _____
   Minute _____

4. Do you currently smoke or vape?
   - Yes
   - No

5. Do you currently consume alcohol?
   - Yes
   - No

APPENDIX C

QUESTIONNAIRE OF ERGONOMICS ASPECTS WHEN LEARNING FROM HOME

This section has 12 questions. Please answers all questions according to your current ergonomic practices during online learning at home.

1. What type of electronic device that you are currently using for learning activities?
   (you can choose more than one)
   - Laptop
   - Desktop
   - Tablet
   - Mobile phone

2. What type of input devices that you currently using for learning activities?
   (you can choose more than one)
   - External Mouse
   - Built in touch pad
   - Touch screen

3. What type of keyboard do you used for learning activities?
   (you can choose more than one)
   - External/separate keyboard
   - Built in keyboard
   - Touch screen

4. Please state how many days do you use electronic device for learning activities in a week.
   _____

5. How long do you spend on electronic device for learning activities in a day?
   Hour_____
   Minute _____

6. Do you take break while carry out learning activities using electronic device?
   - Yes
   - No

7. State the average time that you spend on each break.
   Hour _____
   Minute _____

8. What type of workstation you used for learning activities?
   (you can choose more than one)

- Specific desk for study
- Dining table
- Sofa
- Floor
- Bed
- Others
  Please specify _____

9. Please state the average time you spend for each **workstation that you use** for learning activities based on answer chosen in previous question (hour and minute).
   (you can choose more than one)
   - Specific desk for study _____
   - Dining table
   - Sofa _____
   - Floor _____
   - Bed _____
   - Others
     Please specify _____

10. Chair
    i. Does the chair have arm rest?
       - Yes – adjustable
       - Yes – not adjustable
       - No
       - Not using a chair

    ii. Does the chair have lumbar support?
       - Yes – adjustable
       - Yes – not adjustable
       - No

    iii. Is the chair pan depth adjustable?
       - Yes
       - No

    iv. Is the chair height adjustable?
       - Yes
       - No

    v. What is the condition of your leg when you sitting on your chair currently?
       - Leg hanging
       - Leg touching the ground
       - Leg folding on chair

    vi. Does the chair have castor or roller?
       - Yes
       - No

vii. When sitting while engaging online learning, is your:
(you can choose more than one)

- Back in contact with the back of the chair
- Upper body twisted sideways
- Neck bent forward (flexed)
- Neck bent backwards (extended)
- Neck twisted or bent sideways

11. What do you think of the current lighting at your workstation during learning activities?
    - Dark
    - Dim
    - Sufficient
    - Too bright
    - Glaring to electronic devices

12. Is your vision corrected?
    - Uncorrected vision
    - Corrected with contact lenses
    - Corrected with glasses
    - Corrected with surgery

APPENDIX D

COMPUTER VISION SYNDROME QUESTIONNAIRE

This section has 16 questions. Please answers all questions to indicate whether you experience any of the following symptoms during the time you use the electronic device when learning from home. Mark the frequency and intensity for each symptom according to:

i. First, the frequency, that is, how often the symptom occurs, considering that:
   - Never = the symptom does not occur at all
   - Occasionally = sporadic episodes or once a week
   - Often or Always = 2 or 3 times a week or almost every day

ii. Second, the intensity of the symptom:
   - None = if you indicate Never for frequency
   - Moderate
   - Intense

Nu.	Symptom	Frequency			Intensity	
		Never	Occasionally	Often or Always	Moderate	Intense
1.	Burning					
2.	Itching					
3.	Feeling of a foreign body					
4.	Tearing					
5.	Excessive blinking					
6.	Eye redness					
7.	Eye pain					
8.	Heavy eyelids					
9.	Dryness					
10.	Blurred vision					
11.	Double vision					
12.	Difficulty focusing for near vision					
13.	Increased sensitivity to light					
14.	Colored halos around objects					

15.	Feeling that eyesight is worsening					
16.	Headache					

To be completed by researcher

Calculation of TOTAL SCORE as following expression:

$$Score = \sum_{i=1}^{16} (frequency\ of\ symptom\ occurrence)i \times (intensity\ of\ symptom)i$$

Considering that:

- Frequency:
  - Never = 0
  - Occasionally = 1
  - Often or always = 2
- Intensity:
  - Moderate = 1
  - Intense = 2

Calculation table for computer vision syndrome questionnaire (CVS-Q)

Symptom	**Frequency**	**Intensity**	**Frequency × Intensity**
Burning			
Itching			
Feeling of a foreign body			
Tearing			
Excessive blinking			
Eye redness			
Eye pain			
Heavy eyelids			
Dryness			
Blurred vision			
Double vision			
Difficulty focusing for near vision			
Increased sensitivity to light			
Colored halos around objects			

Feeling that eyesight is worsening			
Headache			
		Score	

If the total score is ≥6 points, the student is considered to suffer Computer Vision Syndrome.

* The result of Frequency x Intensity should be recoded as: 0 = 0; 1 or 2 = 1; 4 = 2

APPENDIX E

RESULTS OF RELIABILITY TEST FOR PRE-TEST DATA

Section	Questionnaire	Cronbach Alpha value	Internal Consistency
4	Computer Vision Syndrome	0.9	Excellent

UNIVERSITI PUTRA MALAYSIA
ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS
(JKEUPM)
UNIVERSITI PUTRA MALAYSIA

Research title	:	**Factor Associated with Computer Vision Syndrome among Students Learning from Home During COVID-19 Pandemic in Malaysia.**
Study Site	:	**Malaysia**
JKEUPM Ref No.	:	**JKEUPM-2020-496**
Researcher	:	**Siti Aina Nabiha Zakaria**
Supervisor	:	**Assoc. Prof. Dr. Ng Yee Guan**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 18/12/2020
2. Respondent Information Sheet & Consent (English), Version 2 dated 22/1/2021
3. Respondent Information Sheet & Consent (Malay), Version 2 dated 22/1/2021
4. Proposal (English), Version 1 dated 18/12/2020
5. Questionnaire/Interview (English), Version 1 dated 18/12/2020
6. Curriculum Vitae of:
    a. Assoc. Prof. Dr. Ng Yee Guan

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.
Decision by JKEUPM:

[x] Approved
[x] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**
[ ] Disapproval

Please note that the approval is **VALID UNTIL 6 FEBRUARY 2022**

Researchers should comply with the following:

I. Complete a Study Final Report upon study completion (Form 3.2).

II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.

III. Applicable for Clinical Trial Studies and Clinical interventional Studies only: Progress Report has to be submitted to JKEUPM at every 6 months from the date of approval (Form 3.1). Report occurrences of all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse Reaction (SUSARs) and Protocol Deviation/ Violation at all JKEUPM approved sites to JKEUPM. SAEs are to be reported within 15 calendar days from awareness of event by investigator. Initial report of SUSARs are to be reported as soon as possible but not later than 7 calendar days from awareness of event by investigator, followed by a complete report within 8 additional calendar days.