AN INVESTIGATION OF COMPUTER VISION SYNDROME IN OPTOMETRY STUDENTS DURING THE COVID-19 OUTBREAK

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ABSTRACT

Introduction: COVID-19 has forced the conventional face-to-face teaching method to online learning. Consequently, students spend more time in front of video display terminals (VDT) which is one of the risk factors for Computer Vision Syndrome (CVS). To date, limited studies have investigated the prevalence of CVS and its associated risk factors during COVID-19. **Aim:** This study aimed to investigate the prevalence of CVS, its associated risk factors and the correlation between CVS presence with the year of study and CVS presence with gender among 85 undergraduate optometry students in Kulliyyah of Allied Health Sciences (KAHS), International Islamic University Malaysia (IIUM). **Methodology:** This cross-sectional study recruited 85 undergraduate optometry students from KAHS, IIUM, who responded to a self-administered online questionnaire. A descriptive analysis was performed to calculate the prevalence of CVS. The Chi-square test and Fisher's Exact Test were conducted to measure the association between CVS and the variables of VDT usage. The phi-correlation coefficient (φ) was conducted to find the association between CVS presence with gender and CVS presence with the year of study. **Results:** The prevalence of CVS was 68.2% among optometry students. There was no statistically significant association ($p>0.05$) between CVS and VDT usage variables. Gender and year of study showed a strong correlation with CVS presence ($\varphi>0.15$). **Conclusion:** The presence of CVS in the study populations warrants further investigation so that measures can be implemented to alleviate this condition, and the learning process could proceed without dire consequences.

KEYWORDS: Computer Vision Syndrome (CVD), COVID-19, visual display terminals (VDT)

INTRODUCTION

The recent COVID-19 has caused unprecedented changes to the whole world. In the education sector, conventional face-to-face teaching is converted to online learning. As such, students spend more time in front of video display terminals (VDT) such as laptops, computers, and smartphones (Noreen, Ali, Aftab, & Umar, 2021). Studies have shown that prolonged use of VDT is one of the risk factors for Computer Vision Syndrome (CVS) (Abudawood, Ashi, & Almarzouki, 2020; Dessie, Adane, Nega, Wami, & Chercos, 2018; Logaraj, Madhupriya, & Hegde, 2014; Noreen, Ali, Aftab, & Umar, 2020; Reddy et al., 2013). CVS is defined as the combination of eye and vision problems associated with the usage of VDT (Rosenfield, 2011).

The optometry students in Kulliyyah of Allied Health Sciences, International Islamic University Malaysia are expected to attend more online classes during the pandemic compared to students from other courses due to their higher credit hours (IIUM, n.d.). Further, it has been proven that in general, students also spend a lot of their time in front of the screen for other academic-related matters such as conducting their research work and finding resources for their study (Altalhi et al., 2020; Noreen et al., 2021). This causes the students to be accustomed to staring at screens for long hours during the period of studying at home, possibly leading them to develop CVS symptoms.

Previous studies found a high prevalence of CVS among university students before the pandemic (Abudawood et al., 2020; Altalhi, Khayyat, Khojah, Alsalmi, & Almarzouki, 2020; Cantó-Sancho, Sánchez-Brau, Ivorra-Soler, & Seguí-Crespo, 2021; Logaraj et al., 2014; Reddy et al., 2013). However, only a few studies have investigated the prevalence of CVS among university students during the COVID-19 pandemic (Noreen et al., 2020; Setyowati et al., 2021). This study aims to investigate the prevalence of CVS and its associated risk factors among optometry students in KAHS during the COVID-19 pandemic. This study also aims to determine the association between CVS with the year of study and CVS with gender in optometry students in KAHS.

Due to the rampant use of electronic devices during online learning, it is hypothesized that the prevalence of CVS among undergraduate optometry students in KAHS will be high during the COVID-19 pandemic. The second hypothesis is that seating position, viewing distance, level of the top of the screen, presence of glare on the screen and duration of use are the associated risk factors for causing CVS. The third hypothesis is that gender and year of study have a strong association with CVS. In

essence, this study will provide data on the prevalence of CVS, its associated risk factors and the association with gender and year of study.

MATERIALS AND METHOD

Study design and population

A retrospective, cross-sectional study was conducted among 85 undergraduate optometry students of KAHS, IIUM. The single population proportion formula was used to calculate the required sample (Daniel, 1999). The following assumptions were taken to calculate the sample size: precision of 5%, the prevalence of CVS at 95% (Abudawood et al., 2020) and confidence interval of 95%. From the calculation, a total sample size of 80 subjects was obtained (after considering the 10% non-response rate). We recruited 85 undergraduate optometry students for this study. All undergraduate optometry students from KAHS who were enrolled during semester 1 2020/2021 were included in this study. There were no exclusion criteria included in this study. This study complied with the tenets of the Declaration of Helsinki, and ethical approval was obtained from IIUM Research Ethics Committee (KAHS 132/21).

Data collection

Optometry student that participated in this study were recruited using convenience sampling and asked to complete an online questionnaire via JotForm, distributed via WhatsApp and email. They were given a summary of the study's aim, objectives, and instructions for completing the questionnaire before data collection commenced. Informed consent was obtained before subject proceeded with this study. The questionnaire comprised of three sections: (i) socio-demographic data, (ii) VDT usages and (iii) symptoms of CVS. The data pertaining to best corrected visual acuity for distance and near was based on the subject's last eye examination. The CVS symptoms and presence were assessed via the CVS-Q (Seguí et al., 2015), while the CVS risk factor was assessed using the questionnaire regarding VDT usage from Peter (2020).

The CVS-Q assesses the frequency and intensity of 16 symptoms associated with CVS, which are burning, itching, foreign body sensation, tearing, excessive blinking, eye redness, eye pain, heavy eyelids, dryness, blurry vision, diplopia, focusing problem, photophobia, seeing coloured halos, worsening sight and headache (Seguí et al., 2015). Subjects were required to report the frequency of the symptoms, whether they occurred "often or always", "occasionally", or "never". If the respondents report "occasionally" or "often", they need to proceed to answer whether the intensity of the symptoms is "moderate" or "intense". The total score was calculated by multiplying the intensity by the total sum of frequency. The respondents were categorized as having a CVS presence when the total score was equal to or exceeded 6 points (Seguí et al., 2015). Subject that participated in this study were asked about the presence of CVS symptoms during the period of studying at home since the closure of universities.

Questions on the usage of VDT were derived from Peter (2020) to investigate the associated risk factors of CVS. The questions consist of seating positions, viewing distance, level of the top of the computer screen and presence of glare while using the VDT. Duration of VDT use was also asked, such as the number of days per week and hours per day they work on the VDT devices. The questionnaire was pre-tested in the pilot study and it was found to be feasible and appropriate to be used (Peter, 2020).

Data analysis

Data analysis was conducted using IBM Statistical Package for Social Science (SPSS) version 23.0 (IBM Corp., Armonk, NY, USA). The normality distribution of the data was analysed using the histogram, skewness and kurtosis value. The assumption of normality for CVS-Q scores was not satisfied, as assessed by visual inspection of the histogram. In addition, the CVS-Q scores had a skewness of 1.179 (SE = 0.261) and a kurtosis of 2.426 (SE = 0.517). According to Leguina (2015) skewness values >+1 or <-1 and kurtosis values >+1 or <-1 are considered non-normal. Based on these criteria, our CVS-Q data were confirmed to be non-normally distributed. Descriptive analysis was conducted for the categorical variables. The frequency and percentages were calculated and presented in Table 1. The prevalence of CVS presence was also calculated. To find the associated risk factors of CVS, Chi-square and Fisher's

exact test were used as univariate analysis and logistic regression was planned to be used as multivariate analysis (Cantó-Sancho et al., 2021). A p-value < 0.05 was taken as significant. Correlation analysis using phi-coefficient (φ) was conducted to test the correlation between CVS presence with gender and CVS presence with the year of study (Akoglu, 2018).

RESULTS

A total of 85 subjects (optometry students) participated in this study. The distribution of the subjects according to socio-demographic data were shown in Table 1. Eighty percent of the subjects were females and twenty percent were males. The highest number of subjects in descending order are from Year 4, Year 3, Year 2, Year 1 and Year 5. A total of eight subjects had the presence of chronic disease, which is allergy (n = 6) and asthma (n = 2). Only 2.4% presented with chronic ocular disease, with one subject having open-angle glaucoma in one eye and coat's disease in another eye (n = 1) and one subject having macular edema in one eye (n = 1). In addition, 10% of subjects reported using contact lenses. Among the 85 subjects, 77.6% had the best corrected visual acuity for distance (BCVA) of 6/6 or better, 9.4% had distance BCVA worse than 6/6, and 12.9% were unsure of their distance BCVA. For BCVA at near, 81.2% had N5 or better, 2.4% worse than N5, and 16.5% were unsure.

For the VDT usage, a total of 50 subjects positioned their face at the same level of the VDT screens, while 25 subjects did not position their face at the same level of VDT. Among the subjects, 25.9% reported the distance with VDT screen greater than 50 cm (> ¾ of arm's length), whereas 74.1% reported less than or equal to 50 cm (~ < ¾ of arm's length). For the level of screen of VDT, 45.9% had the screen below their eye level, 44.7% at the eyes level and 9.4% above the eyes level. Only 11.8% of the subjects used VDT less than 7 days per week whereas 88.2% used VDT every day. Among 85 subjects, 62.4% spent an estimated time from 4 to 8 hours using VDT, while 37.6% spent more than 8 hours daily.

Table 1 Distribution of the subjects (n=85) according to socio-demographic data

Variables	N	%
Gender		
Male	17	20.0
Female	68	80.0
Year of Study		
Year 1	16	18.8
Year 2	18	21.2
Year 3	20	23.5
Year 4	24	28.2
Year 5	7	8.2
Presence of Chronic Disease		
No	77	90.6
Yes	8	9.4
Presence of Chronic Eye Disease		
No	83	97.6
Yes	2	2.4
Use of Contact Lens		
No	75	88.2
Yes	10	11.8
Best Corrected Visual Acuity (Distance)		
6/6 or better	66	77.6
Worse than 6/6	8	9.4
I am not sure	11	12.9
Best Corrected Visual Acuity (Near)		
N5 or better	69	81.2
Worse than N5	2	2.4
I am not sure	14	16.5
Position of VDT screens		
	50	58.8

My face is just at the level of the computer screen / other VDT devices	25	41.2
My face is not at the level of the computer screen / other VDT devices		
Distance with VDT		
Greater than 50 cm (> ¾ of arm's length)	22	25.9
Less than or equal to 50 cm (~ < ¾ of arm's length)	63	74.1
Level of VDT screens		
Below the level of eyes	39	45.9
At the level of eyes	38	44.7
Above the level of eyes	8	9.4
Presence of Glare during VDT use		
No	67	78.8
Yes	18	21.2
Days using VDT (days/week)		
<7	10	11.8
7	75	88.2
Hours using VDT (hours/day)		
4-8	53	62.4
>8	32	37.6

The total prevalence of CVS was 68.2%, with a median score of 7.0 *(IQR* = 4 - 10.5) scores on the CVS-Q (Table 2). For the associated risk factors of CVS, univariate analysis using Chi-square and Fisher's Exact Test did not show any statistically significant result (p>0.05) for the VDT usage variables (Table 2). As for multivariate analysis, we were unable to perform logistic regression to find the associated risk factors of CVS because our data does not satisfy the assumptions required for the test. In particular, data from this study showed no linear relationship between the parameters, presence of outliers and small sample size (Laerd Statistics, 2013).

Table 2 Prevalence of CVS and p-value obtained through univariate analysis (Chi-square and Fisher's Exact Test)

Variables	**N**	**%**	**p-value**
Total	58	68.2	
Gender			
Male	9	52.9	0.221
Female	49	72.1	
Year of Study			
Year 1	10	62.5	0.165
Year 2	9	50.0	
Year 3	17	85.0	
Year 4	18	75.0	
Year 5	4	57.1	
Presence of Chronic Disease			
No	50	64.9	0.051*
Yes	8	100	
Presence of Chronic Eye Disease			
No	57	68.7	0.537*
Yes	1	50.0	
Use of Contact Lens			
No	52	69.3	0.719*
Yes	6	60.0	
Best Corrected Visual Acuity Distance			
6/6 or better	45	68.2	
Worse than 6/6	7	87.5	0.313
I am not sure	6	54.5	
Best Corrected Visual Acuity Near			

N5 or better	47	68.1	
Worse than N5	2	100	0.597
I am not sure	9	64.3	
Position of VDT screens			
My face is just at the level of the computer screen / other VDT devices	33	66.0	0.770
My face is not at the level of the computer screen / other VDT devices	25	71.4	
Distance with VDT			
Greater than 50 cm (> ¾ of arm length	19	86.4	0.064
Less than or equal to 50 cm (~ < ¾ of arm length)	39	61.9	
Level of VDT screens			
Below the level of eyes	30	76.9	
At the level of eyes	23	60.5	0.283
Above the level of eyes	5	62.5	
Presence of Glare during VDT use			
No	42	62.7	0.067
Yes	16	88.9	
Days using VDT (days/week)			
<7	6	60.0	0.719*
7	52	69.3	
Hours using VDT (hours/day)			
4-8	35	71.4	0.616
>8	23	63.9	

VDT: video display terminal
**Fisher's Exact Test*

Based on Figure 1, the most frequent symptoms of CVS from the 16 symptoms according to CVS-Q were itching eyes (65.9%), eye redness (65.9%), eye dryness (64.7%) and headache (62.4%). The least symptoms reported by the subjects were double vision (15.3%) and coloured halos around objects (11.8%).

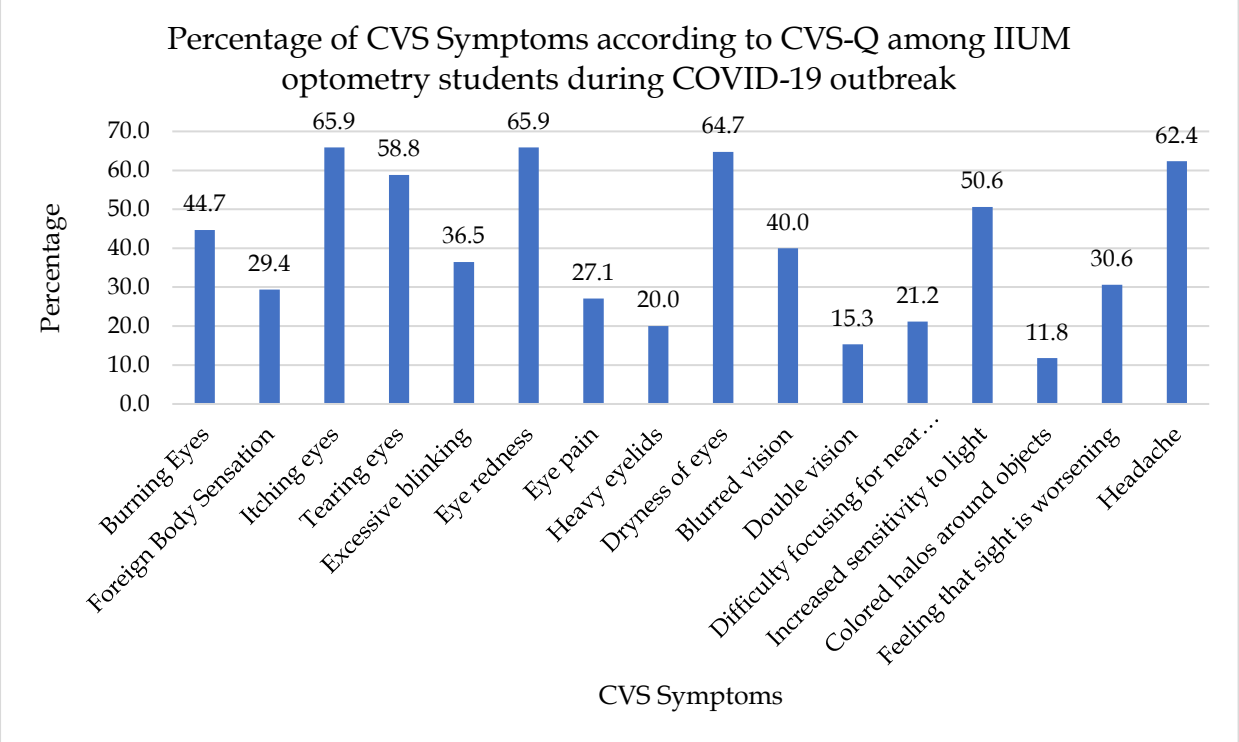

Figure 1 Percentage of CVS symptoms according to CVS-Q among IIUM optometry students during the COVID-19 outbreak

According to Akoglu (2018), the phi coefficient is a measurement of the strength of an association between two categorical variables in a 2×2 contingency table. The value of phi coefficient >0.15 is interpreted as having a strong association. Thus, we conducted a correlation factor analysis using phi-coefficient to assess the strength of associations for two variables; (a) CVS Presence and Gender and (b) CVS Presence and Year of Study. Tables 3 and 4 showed the phi coefficient result according to gender and year of study, respectively. Based on this, it was concluded that gender and year of study were strongly associated with the CVS presence (φ>0.15).

Table 3 Phi coefficient (CVS Presence and Gender)

Gender	CVS Presence (n)		Phi coefficient (φ)
	No	Yes	
Male	8	9	0.164
Female	19	49	

Table 4 Phi-coefficient (CVS Presence and Year of Study)

Year of Study	CVS Presence (n)		Phi coefficient (φ)
	No	Yes	
Year 1	6	10	0.165
Year 2	9	9	
Year 3	3	17	
Year 4	6	18	
Year 5	3	4	

DISCUSSION

The prevalence of CVS obtained from this study was approximate to values obtained in other CVS studies conducted among the university population. A study conducted among Spanish university students, which also utilized the CVS-Q to assess the CVS symptoms, found a prevalence of 76.6% (Cantó-Sancho et al., 2021). The higher prevalence compared to our study may be due to the larger sample size, which is 244 individuals compared to only 85 subjects in our study. There were limited studies available on the prevalence of CVS and its associated factors during the COVID-19 pandemic. A study conducted by Setyowati et al. (2021) found a CVS prevalence of 79.4% among the academic community in Indonesia. The authors did not utilize CVS-Q symptoms, and the presence of at least one of the CVS symptoms was considered of having CVS. Hence, this may lead to a higher prevalence of CVS among their students compared to our study. Meanwhile, Mohan et al. (2020) found a CVS prevalence of 50.23% among children using online e-learning during the COVID19 pandemic. Compared to school children, university students spent prolonged time using VDT for various academic purposes (Noreen et al., 2021). This might explain why the CVS prevalence among school children is lower compared to university students.

Eye itchiness is one of the most frequent CVS-related symptoms reported in other studies (Altalhi et al., 2020; Cantó-Sancho et al., 2021). Altalhi et al. (2020) reported a prevalence of eye itchiness of 63%, while Cantó-Sancho et al. (2021) found a prevalence of 73% among the study population. Similarly, we found a high prevalence of eye itchiness symptoms, 65.9% among KAHS undergraduate optometry students. Headache is another CVS symptom most often experienced among university students (Altalhi et al.,

2020; Noreen et al., 2020; Setyowati et al., 2021). Altalhi et al. (2020) estimated a headache prevalence of 68% among 334 students in Saudi Arabia. We found an approximate prevalence of headaches with Altalhi et al. (2020), which is 62.4 %. In other research, it was discovered that undergraduate medical students in Pakistan and Indonesia experienced a headache prevalence of 16.5% and 40.21%, respectively. (Noreen et al., 2020; Setyowati et al., 2021).

The results from the Chi-square test and Fisher's Exact Test showed that all the investigated factors related to VDT usage were not statistically significantly associated with CVS (Table 2). There was no clear explanation for this and further studies were needed to ascertain the causes. In contrast, Cantó-Sancho et al. (2021) found that longer durations of VDT use were strongly associated with CVS. Specifically, usage of VDT exceeding 4 hours per day imposes a three times risk of developing CVS than using VDT for less than 2 hours. Reddy et al. (2013) also reported that using the computer for more than 2 hours per day would cause a significantly higher number of CVS symptoms ($p < 0.001$).

Phi-coefficient analysis conducted for gender and year of study showed that the presence of CVS was strongly associated with these two variables. Toomingas et al. (2014) found that females are twice as likely to experience CVS symptoms as males. However, Cantó-Sancho et al. (2021) remarked that the association between gender and CVS was unclear. Further studies need to be conducted to determine the association between gender and CVS.

The strength of the current study was that we utilized CVS-Q developed by Seguí et al. (2015) to assess the CVS symptoms and presence. The CVS-Q is a self-administered questionnaire that has been tested and validated by experts (Sánchez-Brau et al., 2020; Seguí et al., 2015). The questionnaire's sensitivity and specificity score derived from Rasch Analysis was more than 70%, and it also obtained good test-retest repeatability (Sánchez-Brau et al., 2020; Seguí et al., 2015). Thus, it is a valid and reliable data tool to assess the CVS symptoms and their severity among subjects. Only a few previous CVS studies used CVS-Q (Cantó-Sancho et al., 2021; Mohan et al., 2020).

The current study had some limitations. The sample was relatively smaller compared to other CVS studies (Abudawood et al., 2020; Noreen et al., 2021; Setyowati et al., 2021) and only included optometry students from KAHS, IIUM. Another limitation of this study was that we did not include questions on CVS preventive strategies such as taking breaks and practice of visual hygiene. In addition, subjects might be subjected to recall bias, similar to any questionnaire-based studies.

CONCLUSION

This study found that the CVS prevalence during the COVID-19 outbreak was 68.2% among the 85 undergraduate optometry students. The most common symptoms reported were eye itchiness, dryness, redness and headache. In this current study, results from Chi-square and Fisher's Exact test showed that the risk factors of VDT usage are not statistically significantly associated with CVS. Hence, we could not identify the associated risk factors of CVS among the subjects. The phi-coefficient test conducted for gender and year of study revealed that both variables were strongly associated with CVS presence. However, due to limited evidence on the associations between gender and CVS presence in the literature, it is recommended to be further explored in future studies. Other recommendations include a larger sample size and involving students from different courses. For future studies, we also recommend incorporating questions on preventive strategies such as frequency of breaks and practice of visual hygiene in the questionnaire. Awareness regarding CVS should be raised, particularly among university students as the symptoms experienced during prolonged use of VDT could be lessened by taking preventive measures.

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