RESEARCH ARTICLE

Computer Vision Syndrome (CVS) among secondary school students in Selangor

Sabrina Subri[1*], Nurin Syahmina Mohd Naziran[2]

[1]Centre of Optometry, Faculty of Health Sciences, Universiti Teknologi MARA Cawangan Selangor Kampus Puncak Alam, 42300 Bandar Puncak Alam, Selangor, Malaysia; [2]Alam Optometry, No 59GF, Jln Setia Perdana BA U13/BA, Bandar Setia Alam, Seksyen U13, 40170 Shah Alam, Selangor, Malaysia.

[*]**Corresponding Author**

Sabrina Subri
Email:
sabrinasubri@uitm.edu.my

Abstract:

Computer Vision Syndrome (CVS) is a group of ocular and vision-related symptoms that manifest after prolonged digital device usage. With increasing use of digital devices especially among teenagers, this study aimed to investigate the prevalence of CVS among secondary school students in Selangor and their level of awareness about this condition. In this cross-sectional study, CVS-Q (Computer Vision Syndrome Questionnaire) (Seguí et al., 2015) was distributed both online and offline to secondary school students in Selangor. The questionnaire included demographic information, general and ocular health conditions, and questions on CVS to determine their awareness about the condition and symptoms of CVS that they have experienced. A total of 202 students, aged between 13 and 18 years, 72.3% of whom were females participated in the study. About 50% of the total participants were reported to have CVS. The most prevalent symptoms experienced by the students were headache (69%) and itchy eyes (69%), followed by burning sensation (60%) and watery eyes (59%); whereas seeing halos around objects (24%) was found to be the least reported symptoms experienced by them. 18.8 % of the participants claimed that they were aware of CVS. The chi-square test revealed that CVS was associated with gender (x^2 (1) = 8.01, p = 0.005) with females being associated with higher CVS scores. The prevalence of CVS among secondary school students in Selangor is considerably high, with higher CVS symptoms found in female participants. A low level of awareness of CVS warrants health education on this matter among this population.

Keywords: Computer Vision Syndrome (CVS), Digital Eye Syndrome (DES), Eyestrain, Headache, Secondary School Students

1. INTRODUCTION

American Optometric Association (AOA) defined Computer Vision Syndrome (CVS) as a group of ocular and vision-related problems that occur due to prolonged use of digital devices such as computers, tablets, cell phones, and e-readers (AOA, 1996). This has been suggested to manifest after more than four hours of continuous use of digital devices such as computers (Irmayani et al., 2020; Blehm et al., 2005). Computers and other digital devices usage require the eye to work harder compared with printed materials. Therefore, increased reliance on digital devices, including computers and smartphones in this digital era, has resulted in increased visual demand, which eventually makes more people susceptible to CVS symptoms. According to Blehm et al. (2005), ocular complaints commonly experienced by computer users include eyestrain, burning sensation, eye fatigue, eye irritation, ocular redness, blurry vision and dry eye sensation. These symptoms may be exacerbated by glare, non-ergonomic workstation setup, poor room illumination, improper computer brightness, and uncorrected refractive error (Torrey, 2003). Additionally, CVS symptoms can also be accompanied by non-ocular symptoms such as headaches, shoulder pain, neck pain, and back pain (Blehm et al., 2005).

Although CVS is more commonly reported among adults, few studies have reported that children are also susceptible to CVS and can experience similar symptoms after prolonged use of computers and digital devices (Kozeis, 2009). In fact, they might be more susceptible to CVS than adults due to less awareness about this condition and the use of less ergonomic workstations that are usually designed for adults. A study in China reported that three-quarters of school children from grade 1 until grade 12 (aged between 6 to 18 years old) experienced CVS symptoms during the Covid-19 pandemic (Li et al., 2021). In addition, similar findings were found in a study conducted among senior high school students in East Java, Indonesia, whereby 87.2% of the students were reported to experience CVS symptoms, particularly dry eye (Loebis et al., 2021). The increased use of digital devices among children and adolescents may lead to tremendous lifestyle changes and an alarming incidence of

visual problems associated with prolonged use of the devices (Ichhpujani et al., 2019). The CVS can reduce work productivity as it requires someone to take frequent breaks when doing a task or else would cause discomfort that may affect one's quality of life. Therefore, increasing the use of digital devices among children and adolescents may pose a public health burden by impacting children's quality of life and possibly their learning process in the long run.

Currently, in Malaysia only the prevalence of CVS among university students and working adults have been reported, while CVS among school children particularly teenagers has not been reported. Therefore, this study aimed to investigate the prevalence of CVS among secondary school students in Selangor and their awareness of the condition. The findings will give a better insight into CVS among secondary school students and determine whether health education on this issue is needed.

2. MATERIALS AND METHODS

2.1 Study design and sample population

A cross-sectional study was carried out among secondary school students in Selangor. Based on a sample size calculation using Raosoft software, for a 95% confidence interval with 5% error, the sample size required for the study was 385 subjects. Participants were recruited via the non-probability selective purposive sampling method. An advert was distributed through various social media platforms to reach the potential participants. All participants were Malaysian secondary school students in Selangor, aged between 13-18 years old with a minimum of three hours of daily exposure to any digital devices including laptops, desktops, tablets or handphones. This criterion has been set to ensure that all participants have access to digital devices prior to taking part in the CVS questionnaire. However, participants with active corneal diseases and a history of ocular surgery were excluded from the study, as these factors can intensify the ocular dryness symptoms and influence their responses to CVS questionnaires (Denoyer et al, 2015; Hardten, 2008).

2.2 Materials

Data were collected using a questionnaire that can be divided into the following sections: (i) demographic information including information on daily usage of digital devices, (ii) medical and ocular health information including medication intake, (iii) questions on awareness of CVS, and (iv) CVS symptoms experienced by the participants which was adopted from CVS-Q (Segui et al, 2015). In section 1 (i), the socioeconomic status was divided into three categories which were B40, M40 and T20. These categories refer to the bottom 40%, middle 40%, and top 20% of the household income distribution in Malaysia, where the thresholds may vary depending on location. In section 3 (iii), participants were asked whether they have heard about CVS before (yes or no) and what measures can be taken to prevent CVS. A ‘yes’ to this question indicates participants were aware of CVS.

Computer Vision Syndrome Questionnaire (CVS-Q)

Questions in Section 4 (iv) of the questionnaires were adopted from CVS-Q (Segui et al, 2015) to determine the prevalence of CVS among the participants. The original questionnaire was developed in English, which was then translated into Malay language and validated in a pilot study (Cronbach’s Alpha >0.7). In this section, participants were asked to indicate the frequency of having CVS symptoms with the response options of "never", "occasionally", "often or always" which were scored as 0, 1 or 2 respectively. If they reported experiencing the symptoms (the answer option of 1 or 2), they were asked to rate the intensity of the symptoms as either "moderate" or “intense" with a score of 1 or 2 respectively.

The CVS score for each symptom was then calculated by multiplying the frequency with the symptoms (frequency X intensity). Scores for 16 symptoms were summed up to get the total CVS score. A total CVS score of six or more (≥6) was considered as having CVS.

2.3 Procedures

This study was conducted both online and offline where Google Form was used to create the online version of the questionnaire, while the printed version was distributed to several secondary schools around Shah Alam. Consent and assent forms were attached together with the questionnaire for both online and offline methods which were filled in by all participants and their parents before answering the questionnaire. The study was conducted in accordance to the Declaration of Helsinki and was approved by the ethical committee of the university (FERC/FSK/MR/2022/0076).

2.4 Data analysis

Data collected were analysed using SPSS version 27.0. The data were tested for normality using the Kolmogorov-Smirnov test. Descriptive statistic was used to describe the prevalence and awareness of CVS among secondary school students. Since the CVS scores were not normally distributed ($p<0.05$), Mann-Whitney test was used to compare the scores between upper and lower secondary school students, different genders and socioeconomic status. In addition, the associations between these factors and CVS categories were

also assessed using Pearson's Chi-square test with an alpha value set at 0.05.

3. RESULTS

A total of 202 secondary school students participated in this study, with 105 lower secondary and 97 upper secondary students. Lower secondary school students were between 13 to 15 years of age (M = 13.91; SD = 0.71), while upper secondary school students were between 16 to 18 years of age (M = 16.98; SD = 0.82). The demographic data of the participants were as follows (Table 1).

Table 1. Demographic data of participants

Demographic variables	Frequency (n=202)	Percentage (%)
Age group		
Lower secondary school	105	52.0
Upper secondary school	97	48.0
Gender		
Male	56	27.7
Female	146	72.3
Family's socioeconomic status		
B40	73	36.1
M40	100	49.5
T20	29	14.4
School		
Government	193	95.5
Private	9	4.5
Duration of daily digital devices use		
<5 hours	52	25.7
≥5 hours	150	74.3

The mean duration of daily digital devices use was 8.09 hours (SD = 5.30). The most frequently used device was mobile phone (88%) followed by tablet (5%), laptop (4%) and desktop (3%). Out of the 202 participants, only 38 (18.8 %) of them have heard of CVS before, while 137 (67.8%) participants knew that limiting the screentime will help to reduce CVS. Among the 38 participants who were aware of CVS, majority of them were from lower secondary (57.9%) and were female (84.2%) students.

Figure 1 shows percentage of participants reporting each CVS symptom. 167 (82.7%) of the students had at least one symptom of CVS. Three most common symptoms experienced by the students were headache (69%), itchy eyes (69%) and burning sensation (60%) while the least common symptom was halos (24%).

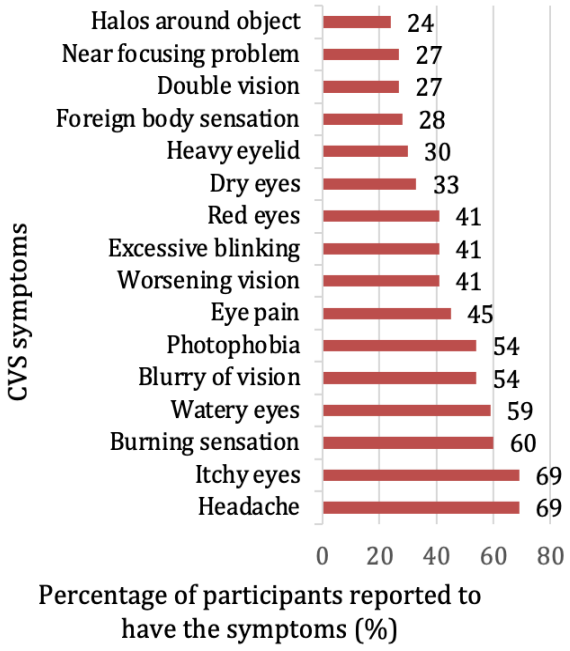

Figure 1. CVS symptoms reported by participants.

Based on the total CVS scores (M = 6.08; SD = 4.83), 50% (n=101) of the participants were considered as having CVS. Mann-Whitney test was used to compare CVS score between students who were aware of CVS (Mdn = 7; IQR = 7) and those who have not heard about CVS before (Mdn = 5; IQR = 7). Results showed no significant difference in CVS scores between the two groups (z = -0.786, p-value = 0.433).

CVS scores were also compared between lower and upper secondary students using Mann-Whitney test. Results showed that the CVS score between lower secondary (M = 5.40; SD = 4.54) and upper secondary (M = 6.81; SD = 5.04) school students missed the significance with the upper secondary students had a slightly higher scores (u = 4302, p = 0.056). On the other hand, Mann-Whitney test showed a significant difference in CVS scores between gender, with a higher CVS score found in female (Mdn = 7; IQR = 7) compared with male participants (Mdn = 3.50; IQR = 9) (z = -2.933, p-value = 0.003).

CVS score was also compared between three different groups of family's socioeconomic status using the Kruskal-Wallis test. No significant difference was found in CVS scores between different socioeconomic groups (Table 2).

Table 2. Total CVS score between different socioeconomic status

Family's socioeconomic status	n	Median (IQR)	*X* statistic (df)*	*p*-value*
B40	73	5.00 (8)	0.771 (2)	0.680
M40	100	6.50 (8)		
T20	29	5.00 (6)		

Note. *Kruskal-Wallis test was used to compare CVS scores between groups.

Additionally, Chi-square test showed that the only variable associated with CVS categories was gender (x^2 (1) = 8.01, p = 0.005), with females associated with a higher CVS score. There was no significant association found between CVS categories and age groups (x^2 (1) = 0.972, p = 0.324), family's socioeconomic status (x^2 (2) = 1.35, p = 0.510), and awareness of CVS (x^2 (1) = 2.07, p = 0.150).

Moreover, the associations between awareness of CVS with age, gender and family's socioeconomic status were also tested using the Chi-square test. Results showed no association between awareness of CVS with age (x^2 (1) = 0.66, p = 0.418), and family's socioeconomic status (x^2 (2) = 3.44, p = 0.179). However, the association between awareness of CVS and gender was approaching significant, with females being slightly more aware of CVS (x^2 (1) = 3.33, p = 0.068). Pearson's correlation coefficient test also showed no significant correlation between CVS score and hours spent on digital devices (r = 0.05, p = 0.479) as well as age (r = -0.05, p = 0.717).

4. DISCUSSION

The study aimed to determine the prevalence of CVS among secondary school students in Selangor and their awareness of CVS. Results showed half of the participants were considered as having CVS, with a higher CVS score obtained among female participants. In addition, female students were more aware of CVS compared to male students.

The prevalence of CVS seems to be varied with different occupations and the nature of work. A study by Assefa et al. (2017) reported that the prevalence of CVS among computer-based bank workers in Gondar was 73% which was somewhat similar to another study among computer office workers in Sri Lanka (67.4%) (Ranasinghe et al., 2016). A similar percentage was also found among university administrative staff in Malaysia, with 63% of the sample reported to have CVS (Zainuddin & Isa, 2014). A higher prevalence of CVS was reported among university students in Jordan (94.5%) (Gammoh, 2021), Saudi Arabia (97.3%) (Altalhi et al., 2020) and Malaysia (89.9%) (Reddy et al., 2013). However, our study involving secondary students reported a slightly lower prevalence of CVS compared to the earlier studies, possibly due to the duration of daily screentime, which was much shorter and less intensive among secondary school students compared to office workers and university students.

On the other hand, a recent study among secondary school students of a similar age range in Thailand showed a higher prevalence of CVS (70.1%) (Seresirikachorn, 2022) compared to our study. This may be attributed to the timeline when the study was conducted in Thailand, which was earlier during the Covid-19 pandemic. During that time, the duration of digital devices usage per day was still relatively higher due to implementation of online learning instead of physical classes. In contrast, our study was conducted post-Covid period, where majority of the physical educational activities have gone back. Despite a slightly lesser prevalence of CVS among the students due to a shorter daily screentime, the findings of more than 50% prevalence of CVS indicates majority of the secondary school students are at risk of having ocular health problems if this issue is not addressed.

Among the symptoms reported, headache and itchy eyes were the most common CVS symptoms experienced by the participants. This was in agreement with studies reported in other countries such as Saudi Arabia (Al Tawil et al., 2020), Tokyo (Sen & Richardson, 2007) and India (Bali et al., 2007) where the prevalence of headache was relatively high compared to other symptoms reported by their study populations. There are multiple factors contributing to headaches when using digital devices which include short viewing distance that increases accommodation demand and the constant change in accommodation due to poor edge resolution. Altogether, these will make the eyes work harder, putting extra stress on the extraocular muscle which eventually lead to headaches (Ranasinghe et al., 2016).

Regarding factors associated with CVS symptoms, our results demonstrated that only gender has an association with CVS categories with a higher prevalence found in females compared to males, which was similar to those reported in previous studies (Rahman & Sanip, 2011; Agbonlahor, 2019). This gender difference may be attributed to the non-ergonomic setting for female users and the possible influence of hormonal changes in female students. Females usually have a shorter stature and arm reach compared to males, therefore more likely to have a closer viewing distance and non-ergonomic position when using computers, increasing the risk of musculoskeletal problems that may contribute to increase in CVS symptoms (Mowatt, 2018). Future study can explore the underlying factors contributing to the gender difference in CVS reported in this study.

Research have shown that CVS might be associated with age differently depending on the nature of work of the study population. Some studies have reported that CVS symptoms such as dry eyes and headache were more prevalent in older age (Bigal et al., 2006; Ranasinghe et al., 2016; de Paiva, 2017), while some reported a higher prevalence of CVS in the younger group (Rahman & Sanip, 2011; Wangsan et al, 2022). This difference was driven by the duration of digital devices usage where the age group with a longer duration of usage had a higher prevalence of CVS in each study. Contrasting to the previous studies, our study showed no association between CVS and age groups. A possible reason for this was due to the age range of the sample participated in our study, which was only among secondary school students with a small age range therefore a weaker association between age and CVS score. In addition, we also found no association between the prevalence of CVS and family's socioeconomic status, suggesting the widespread use of digital devices, hence CVS across all socioeconomic levels.

Furthermore, our finding suggests that most of the secondary school students were unaware of CVS. This indicates a notable knowledge gap about CVS in the studied population. However, the absence of an association between awareness of CVS and the condition indicates that simply being aware of the condition is not sufficient to prevent CVS. This implies that health education is necessary not only to increase knowledge and understanding of CVS, but also to instill self-awareness in reducing CVS among this group. Employing a multifaceted approach to educate teenagers about CVS, such as educational campaigns at school, peer education through social stories, as well as parental involvement, would be some of the effective initiatives for this group.

Despite the additional knowledge provided by this study, it is important to note its limitations. The results obtained were only based on self-reporting symptoms by the participants with no clinical examination to rule out whether the participants have uncorrected refractive error or binocular vision anomalies that can contribute to CVS. In addition, study population was restricted to several schools around Selangor with a smaller age range, with most of them were staying at the hostel during the day. This may underestimate the prevalence of CVS among school children who were staying at home and have more access to digital devices. Moreover, the higher percentage of female respondents in this study might also contribute to the significant association between gender and CVS symptoms as mentioned earlier. Notwithstanding this, the presence of CVS in the majority of the participants is alarming, therefore warrants health education initiatives on this matter among secondary school children to ensure long-term sustainable well-being of the future generation.

5. CONCLUSION

This study provides an initial overview of CVS symptoms among secondary school students in Malaysia. CVS was found to be prevalent among secondary school students in Selangor with a higher prevalence found in females compared to male students which could potentially impact on their health and academice performance. Considering only a small percentage of the participants were aware of CVS, health education on this matter among school students is needed to spread the knowledge and awareness of CVS, as well as instilling self-awareness in practicing good habit to prevent this condition. This will help to ensure the long-term sustainable well-being of our future generation.

ACKNOWLEDGEMENTS

We would like to thank the two translators, parents and secondary school students who participated in this study.

REFERENCES

Agbonlahor, O. (2019). Prevalence and knowledge of computer vision syndrome (CVS) among the working class adults in FCT Nigeria. *Journal of the Nigerian Optometric Association*, 21(1), 49-60.

Al Tawil, L., Aldokhayel, S., Zeitouni, L., Qadoumi, T., Hussein, S., & Ahamed, S. S. (2020). Prevalence of self-reported computer vision syndrome symptoms and its associated factors among university students. *European Journal of Ophthalmology*, 30(1), 189–195. https://doi.org/10.1177/1120672118815110

Altalhi, A., Khayyat, W., Khojah, O., Alsalmi, M., & Almarzouki, H. (2020). Computer vision syndrome among health sciences students in Saudi Arabia: prevalence and risk factors. *Cureus*, 12(2).

American Optometric Association. (1995). Guide to the clinical aspects of computer vision syndrome. St. Louis: American Optometric Association, 1.

Assefa, N. L., Weldemichael, D. Z., Alemu, H. W., & Anbesse, D. H. (2017). Prevalence and associated factors of computer vision syndrome among bank workers in Gondar City, northwest Ethiopia, 2015. *Clinical Optometry*, 9, 67-76. https://doi.org/10.2147/OPTO.S126366

Bali, J., Navin, N., & Thakur, B. R. (2007). Computer vision syndrome: a study of the knowledge, attitudes and practices in Indian ophthalmologists. *Indian journal of ophthalmology*, 55(4), 289- 293.

Bigal, M. E., Liberman, J. N., & Lipton, R. B. (2006). Age-dependent prevalence and clinical features of migraine. *Neurology*, 67(2), 246–251. https://doi.org/10.1212/01.wnl.0000225186.76323.69

Blehm, C., Vishnu, S., Khattak, A., Mitra, S., & Yee, R. W. (2005). Computer vision syndrome: A review. *Survey of Ophthalmology*, 50(3), 253–262. https://doi.org/10.1016/J.SURVOPHTHAL.2005.02.008

Denoyer, A., Landman, E., Trinh, L., Faure, J. F., Auclin, F., & Baudouin, C. (2015). Dry eye disease after refractive surgery:

comparative outcomes of small incision lenticule extraction versus LASIK. *Ophthalmology*, 122(4), 669-676.

de Paiva C. S. (2017). Effects of Aging in Dry Eye. *International ophthalmology clinics*, 57(2), 47–64. https://doi.org/10.1097/IIO.0000000000000170

Gammoh Y. (2021). Digital Eye Strain and Its Risk Factors Among a University Student Population in Jordan: A Cross-Sectional Study. *Cureus*, 13(2), e13575. https://doi.org/10.7759/cureus.13575

Hardten, D. R. (2008). Dry eye disease in patients after cataract surgery. *Cornea*, 27(7), 855.

Ichhpujani, P., Singh, R. B., Foulsham, W., Thakur, S., & Lamba, A. S. (2019). Visual implications of digital device usage in school children: A cross-sectional study. *BMC Ophthalmology*, 19(1), 1–8. https://doi.org/10.1186/S12886-019

Irmayani, A.I, Siregar, A. F., Lubis, A. S., Pratama, M. Y., & Lubis, F. H. (2020). Design and Trial of Computer Vision Syndrome Level Instruments. *Proceedings of the International Conference on Health Informatics and Medical Application Technology*, 128–134. https://doi.org/10.5220/0009467201280134

Kozeis N. (2009). Impact of computer use on children's vision. *Hippokratia*, 13(4), 230–231.

Li, R., Ying, B., Qian, Y., Chen, D., Li, X., Zhu, H., & Liu, H. (2021). Prevalence of Self-Reported Symptoms of Computer Vision Syndrome and Associated Risk Factors among School Students in China during the COVID-19 Pandemic. *Ophthalmic Epidemiology*. 29(4), 363–373. https://doi.org/10.1080/09286586.2021.1963786

Loebis, R., Subakti Zulkarnain, B., & Zahra, N. (2021). Correlation between the exposure time to mobile devices and the prevalence of evaporative dry eyes as one of the symptoms of computer vision syndrome among Senior High School students in East Java, Indonesia. *Journal of Basic and Clinical Physiology and Pharmacology*, 32(4), 541–545. https://doi.org/10.1515/JBCPP-2020-0478

Logaraj, M., Madhupriya, V., & Hegde, S. K. (2014). Computer Vision Syndrome and Associated Factors Among Medical and Engineering Students in Chennai. *Annals of Medical and Health Sciences Research*, Mar-Apr, 4(2), 179.

Mowatt, L., Gordon, C., Santosh, A. B. R., & Jones, T. (2018). Computer vision syndrome and ergonomic practices among undergraduate university students. *International journal of clinical practice*, 72(1), e13035.

Rahman, Z. A., & Sanip, S. (2011). Computer user: demographic and computer related factors that predispose user to get computer vision syndrome. *Int J Bus Humanit Technol*, 1(2), 84-91.

Ranasinghe, P., Wathurapatha, W. S., Perera, Y. S., Lamabadusuriya, D. A., Kulatunga, S., Jayawardana, N., & Katulanda, P. (2016). Computer vision syndrome among computer office workers in a developing country: an evaluation of prevalence and risk factors. *BMC Research Notes*, 9(1). https://doi.org/10.1186/S13104-016- 1962-1

Reddy, S. C., Low, C. K., Lim, Y. P., Low, L. L., Mardina, F., & Nursaleha, M. P. (2013). Computer vision syndrome: a study of knowledge and practices in university students. Nepalese Journal of Ophthalmology: A Biannual Peer-Reviewed *Academic Journal of the Nepal Ophthalmic Society : NEPJOPH*, 5(2), 161–168. https://doi.org/10.3126/NEPJOPH.V5I2.8707

Sen, A., & Richardson, S. (2007). A study of computer-related upper limb discomfort and computer vision syndrome. *Journal of Human Ergology*, 36(2), 45–50. https://doi.org/10.11183/JHE1972.36.2_45

Seresirikachorn, K., Thiamthat, W., Sriyuttagrai, W., Soonthornworasiri, N., Singhanetr, P., Yudtanahiran, N., & Theeramunkong, T. (2022). Effects of digital devices and online learning on computer vision syndrome in students during the COVID-19 era: an online questionnaire study. *BMJ Paediatrics Open*, 6 (1), e001429.

Shrestha, G. S., Mohamed, F. N., & Shah, D. N. (2011). Visual problems among video display terminal (VDT) users in Nepal. *Journal of Optometry*, 4(2), 56-62.

Torrey, J. (2003). Understanding computer vision syndrome. *Employment Relations Today*, 30(1), 45–51. https://doi.org/10.1002/ERT.10073

Wangsan, K., Upaphong, P., Assavanopakun, P., Sapbamrer, R., Sirikul, W., Kitro, A., Sirimaharaj, N., Kuanprasert, S., Saenpo, M., Saetiao, S., & Khamphichai, T. (2022). Self-Reported Computer Vision Syndrome among Thai University Students in Virtual Classrooms during the COVID-19 Pandemic: Prevalence and Associated Factors. *International Journal of Environmental Research and Public Health*, 19(7), 3996. https://doi.org/10.3390/ijerph19073996

Zainuddin, H., & Isa, M. M. (2014). Effect of human and technology interaction: computer vision syndrome among administrative staff in a public university. *International Journal of Business, Humanities and Technology*, 4(3), 38-44.

