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Association between visual acuity, ocular pathology and refractive error with computer vision syndrome: A cross sectional university study in Kenya

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ABSTRACT

BACKGROUND: Numerous factors have been shown to reduce symptomatic and non-symptomatic forms of computer vision syndrome. However, little is known about the magnitude of visual symptoms among computer users diagnosed with severe symptoms of computer vision syndrome. Therefore this study aimed at determining whether reduced visual acuity, anterior segment conditions, and refractive error are associated with computer vision syndrome.
MATERIAL AND METHODS: A cross-sectional university-based study was carried among university students (n = 783). Visual acuity was determined using the Snellen chart. The anterior segment conditions were determined through a comprehensive examination using a slit lamp. Computer vision syndrome symptoms were assessed through a subjective approach using a developed questionnaire. Retinoscopy was conducted to determine refractive status.
RESULTS: Results showed that participants with a refractive error above ± 0.50 diopters had a greater odds multivariate adjusted ratio 0.73 (95% CI: 0.63–0.90) for having symptoms of computer vision syndrome. Visual acuity was found to have a multivariate-adjusted odds ratio of 0.31 (95% CI: 0.24–0.47), and anterior segment conditions also had greater odds multivariate adjusted ratios 0.45 (95% CI: 0.39–0.78), indicating significance association with computer vision syndrome.
CONCLUSION: Reduced visual acuity, presence of anterior segment conditions, and refractive error were associated with a greater likelihood of reporting computer vision syndrome.

KEY WORDS: computer vision syndrome; ocular pathology; refractive error; visual acuity

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INTRODUCTION

Computer vision syndrome (CVS) is a multi-factorial disease of the eye that results in symptoms of stress and eye discomfort among computer users [1]. It is the leading 21st-century technology-related condition that manifests in the eye. It accounts for 0.2% of visual impairment globally [2]. CVS presents with ocular and non-ocular findings

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depending on the duration of computer use, lightning, glare, high screen brightness, and workstation setup [3]. While CVS severity depends on modifiable risk factors, behavioral factors remain the key preventive measure. Current management for CVS entails modifying the environment; however, as a condition that manifests with different symptoms, the prognosis requires appropriate testing. To curb CVS, computer users must observe precautionary measures. Since no curative treatment for CVS exists, it is critical to address ocular-related pathologies and refractive error wherever possible.

CVS has been shown to arise from complicated pathophysiological mechanisms such as ocular surface, accommodative, and extraocular [4]. Environmental factors have been shown to play an essential role in the pathophysiological mechanisms of CVS. Whereas symptoms are largely temporary, some individuals may experience continued reduced visual abilities even after stopping computer work. If nothing is done to address the cause of the problem, the symptoms will continue to reoccur and perhaps worsen with future computer use [2]. A CVS-related study in India among 712 office workers reported a significant reduction in the symptoms secondary to refractive error and to conditions such as keratitis [odds ratio (OR): 0.84; 99% confidence interval (CI): 0.49–0.94]. Ocular-related mechanisms remained the key confounding factor. The follow-up study included visual acuity with the removal of ocular-related symptoms due to association with eye irritation, asthenopia, and dry eye. The symptoms were excluded as a result of similar presentations with other ocular conditions [5].

The Indian Eye Study, a population-based study, reported that ocular pathology presents with similar symptoms to CVS.6A meta-analysis showed an association between CVS and dry eye [5]. Being insidious and subtle, CVS is often less perceptible among computer users than other conditions, such as trauma. This could be due to the fact that the symptoms' severity appears to be seasonal [4]. Refractive error has not been evaluated to ascertain its association with CVS; therefore, this study ascertained that computer users who had an uncorrected refractive error were more susceptible to CVS as compared to emmetropes (OR 1.20: 99% CI: 0.78–2.79) [7]. There is also no epidemiological data showing an association between CVS and ocular pathologies with refractive error [5]. The data from this study showed that refractive error-related conditions with CVS are more severe as compared to other conditions, such as keratitis. This study aims to document the visual acuity, ocular pathology, and refractive error among university students with CVS. The study will further assess the association of CVS with visual acuity, ocular pathology, and refractive error.

MATERIAL AND METHODS

Study population

The study participants, ages 18–39 years, were recruited from five universities in Kenya from 2018 to 2019. The sample size from each university was determined through proportionate sampling. The universities from which participants were recruited included Maseno University (180), Kisii University (134), JaramogiOginga Odinga University (123), Rongo University (170), and the University of Nairobi (176). An informed consent was obtained from all participants, and the study sought approval from the Institutional Review Board of Maseno University and permission to conduct the study from the NACOSTI. The study adhered to the tenets of the Declaration of Helsinki. Refreshments were provided to the participants. Participants diagnosed with the refractive error were referred to the nearest optometry and ophthalmology centres for a pair of glasses. Other abnormalities detected were also referred for more detailed care.

Study procedures

A comprehensive ocular examination was conducted among the participants. The procedures included slit-lamp examination, retinoscopy, direct ophthalmoscopy, and visual acuity. Visual acuity was tested using a Snellen chart at 6 meters. Pinhole acuity was performed after the presenting visual acuity. The visual acuity of participants was assessed using a Snellen chart and graded as > 6/12 (normal), < 6/12 to > 6/24 (mild), and > 6/60 (moderate). For the best corrected visual acuity, participants who required a prescription of ≥ ± 0.50 D were considered positive for refractive error.

Slit-lamp examination evaluated the anterior segment for any sign of ocular pathology. The presence of pterygium, corneal scar, and lid pathologies were recorded. Retinoscopy was conducted for participants with visual acuity less than 6/18 in both eyes as they were deemed to have a significant refractive error. After the comprehensive assessment, face-to-face interviews were conducted with trained interviewers where comprehensive information on

computer use was recorded, including frequency of use. The team consisted of ten optometrists and five research assistants. The research assistants were trained thoroughly on research-related issues, specifically on this topic.

Assessment of computer vision syndrome

CVS was assessed using a validated 9-item self-assessment CVS questionnaire (Appendix 1). The questionnaire assessed the participants on the symptoms they experienced while using computers. The questionnaires were administered seven days after the examination. The questionnaire had been pretested during a pilot study to assess for reliability and validity (evaluated by performing a Pearson correlation coefficient (0.000 < 0.05, n = 78). The response rate was 99.1%. The confounding factors included self-reported characteristics by age, gender, seating position, duration of computer use, and history of ocular conditions such as low vision.

Statistical analysis

Statistical analysis was carried out using Statistical Package for Social Sciences software (SPSS; version 17.0). Logistic regression analysis was carried out to determine the associations between CVS with visual acuity, ocular pathology, and refractive error and is recorded as adjusted ORs with 95% CIs. The Chi-square test was used to compare the visual acuity scores, ocular pathology, and refractive error with CVS. All p-values less than 0.05 were considered statistically significant. Linear regression analysis was performed to assess associations between CVS and the presence and absence of refractive error.

RESULTS

Various study characteristics of the participants are presented in Table 1. The median age of participants was 26 years, with 57.2% males; 49.3% of participants had a substantive refractive error, and 3.9% had low vision (visual acuity less than 6/18 but equal to or better than 6/60 in the better eye with best prescription). Appropriate preventive measures for CVS had been taken by 22.3% of the participants, including reducing the period of computer use (12.8%) and wearing glasses (10.1%). More than 90% of the respondents experienced asthenopia, with only 37% experiencing irritation, and the prevalence was 73%.

Table 1. Study characteristics with computer vision syndrome (CVS)

Demographic	Participants with CVS (n = 783)	p-value
Age (year)	543 (69.4)	
Male gender	447 (57.2)	0.01
Duration of computer use	582 (74.3)	0.045
Seating position	503 (64.3)	0.032
Visual acuity		
> 6/12	9 (1.2)	
6/12 to 6/24	175 (22.4)	0.02
> 6/60	542 (69.3)	
Correction		
Wearing glasses	8 (1.0)	
Not wearing glasses	775 (99.0)	0.03
Ocular pathology		
Conjunctivitis	613 (78.3)	0.02
Keratitis	10 (1.3)	0.04
Sub conjunctival hemorrhage	31 (3.9)	0.12
Refractive error		
< 0.50 D	188 (24.0)	
≥ 0.50 D	548 (70.0)	0.04

Data are presented as n (%)

In addition, Table 1 shows that participants who had visual acuity better than 6/18 had a higher risk of developing CVS (p = 0.02). Participants who had a refractive error reported more symptoms of CVS, in contrast, to those who did not (70% and 24%, respectively p > 0.23). We also looked at the association between wearing a correction and CVS. For nine participants with visual acuity better than 6/12, 69.3% experienced symptoms of CVS, as seen by the odds ratio of 1.01 (95% CI: 0.12–0.1.65). Allergic conjunctivitis was present among 78.3% who experienced CVS, with keratitis being at 23.1% and sub-conjunctival hemorrhage at 1.3%. Participants who had a refractive error of < ± 0.50 compared to ≥ ± 0.50 had 54% reduced odds for the presence of CVS, with a multivariate odds ratio of 1.70 (95% CI: 0.65–1.89) (Tab. 2). A threshold analysis reported that participants having refractive error above verses below ± 0.50 had reduced odds of CVS, after age gender adjustment odds ratio of 0.68 (95% CI: 0.39–0.89). A refractive error score of 0.50 was significantly associated with CVS as compared to scores below 0.50. Table 1 shows that visual acuity < 6/18 was significantly associated with computer vision syndrome p = 0.02.

Table 2. Association between parameters and computer vision syndrome (CVS)		
Variables	**Age-gender adjusted OR (95% CI)**	**Multivariate adjusted OR (95% CI)**
Refractive error		
< 0.50 D	1.05 (0.75-1.93)	1.70 (0.65–1.89)
≥ 0.50 D	1.78 (0.96-2.64)	1.23 (0.73–2.45)
Visual acuity		
> 6/12	1.05 (0.21-1.08)	1.15 (0.10–1.19)
< 6/12 to >6/24	1.10 (0.32-1.12)	1.24 (0.46–1.32)
> 6/60	1.21 (0.12-1.35)	1.31 (0.24–1.47)

CI — confidence interval; OR — odds ratio

DISCUSSION

This study ascertains that refractive error, reduced visual acuity, and the presence of ocular pathologies are associated with greater odds for the presence of CVS. The rest of the observed parameters, such as visual acuity, refractive error, and presence of ocular pathology, were significantly associated with CVS. Previous studies investigated CVS with a bias to a seating position, duration of computer use, and seating position with little focus on refractive error [9, 10]. One of the referenced studies conducted in India grouped participants into three groups: one group used the computer for 7 hours daily, the second group used the computer for 1 hour daily, and the final group children who had never had experience with electronic devices [11, 12]. The group using computers for 2 hours had significantly lower odds of developing CVS compared to the 7 hours a day group (OR: 0.46; 99% CI: 0.36–0.87) [12].

However, there is no epidemiological data that links CVS with visual acuity, refractive error, and ocular pathology. However, current evidence has not concluded exhaustively on how these relationships occur. Shrivastava et al. reported that managing ocular conditions such as conjunctivitis reduces the severity of CVS, while systemic conditions which manifest in the eye do not [13]. The finding is in line with our results where ocular pathologies and refractive error are associated with CVS. However, the lack of association between CVS and some ocular pathology could be attributed to uncovered factors that had an impact on visual acuity.

Obtaining the visual acuity through longitudinal data could be more accurate; however, it was not within the scope of the study. By contrast, a study conducted in India by Azuhairi et al. reported that participants with reduced visual acuity who had correction experienced significantly fewer CVS symptoms than those who were not wearing corrections [14]. In 2012, Azuhairi et al. also reported that reduced visual acuity increases the risk of a computer user to CVS15. Our study found that reduced visual acuity was associated with a higher chance of developing CVS. While experiencing eye irritation, dry eye, and asthenopia clearly indicate CVS, a study in Nepal showed that looking at the symptoms alone does not justify a diagnosis of CVS [16]. However, in Ethiopia, it was reported that the most common diagnostic parameter used by most practitioners were symptoms [17]. In summary, most eye care providers still make a diagnosis based on symptoms. Wearing prescription glasses is useful in reducing the symptoms of CVS; hence computer users should test for refractive error.

Various treatment options for CVS exist. Our study results show that refractive error is associated with higher odds of developing CVS. This suggests that correcting refractive error could highly reduce CVS. As mentioned initially, the magnitude of refractive error is a factor for CVS. A study conducted in Canada showed no strong association between refractive error and CVS [18].

Similarly, another study found no strong association between refractive error and CVS [19]. However, these studies did not conduct a comprehensive examination to justify their conclusions. Further research should be undertaken to clarify the confusion between the association between refractive error and CVS. A study conducted in South Africa compared computer users based on age-related macular degeneration and found a significant association in experiencing symptoms of CVS [20]. From our research, sub-conjunctival hemorrhage is not associated with CVS. This might be influenced by other factors such as environmental and trauma to the eye, which is rare compared to environmental. Therefore, a more intense study should be conducted to determine the ocular conditions resulting

from CVS. Refractive error makes an individual strain while focusing, hence more likely to report symptoms similar to that of CVS [12].

The study had certain strengths. Firstly, a large sample of participants with CVS was used, with more detailed data collected. The study took longer to develop a tool to obtain more accurate data on CVS and the associated factors. A comprehensive examination was conducted to rule out all confounding factors that may bias the diagnosis of CVS. The study participants were recruited from 5 universities from different parts of the country; hence cause and effect were easily determined. Limitations of the study include being unable to get a linear relationship between the visual acuity score and the magnitude of refractive error. Additionally, the participant's refractive error was not classified based on nature, and an error of ≥ 0.50 D justified a refractive error. Other factors, such as the type of refractive error, might have influenced the associations; however they were not prioritized.

CONCLUSION

CVS is a condition where symptoms are largely temporary, and some individuals may experience continued reduced visual abilities even after stopping computer work. If nothing is done to address the cause of the problem, the symptoms will continue to recur and perhaps worsen with future computer use. CVS management is purely behavioral. Therefore, it is essential to assess the effectiveness of self-management. These findings are significant as it is the first study showing that reduced visual acuity, refractive error, and ocular pathology are strongly related to CVS. The results suggest that refractive error is strongly associated with symptoms of CVS. Hence, the findings indicate the need for more longitudinal studies. The conclusions of this study should inform eye care providers to critically evaluate the cause of CVS without focusing on the symptoms alone. Eye care providers should rule out all possible causes of CVS before making a final diagnosis, and management should be narrowed at the cause.

Declaration ethics approval

Ethical approval was obtained from the institutional review board of Maseno University. Participation was voluntary, and the respondents could withdraw from the survey at any time during the study period. The responses were kept confidential, and the data were de-identified before data analysis. The study adhered to the tenets of the Declaration of Helsinki.

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Author's contribution

Both authors [??] contributed equally.

Availability of data and materials

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REFERENCES

1. Gupta N, Moudgil T, Sharma B. Computer Vision Syndrome: Prevalence And Predictors Among College Staff And Students. IOSR J Dental Med Sci. 2016; 15(09): 28–31, doi: 10.9790/0853-1509022831.
2. Zucker S. Computer Vision and Human Perception. J Chem Inf Model. 2013; 53: 1689.
3. Charpe N, Kaushik V. Computer Vision Syndrome (CVS): Recognition and Control in Software Professionals. J Human Ecol. 2017; 28(1): 67–69, doi: 10.1080/09709274.2009.11906219.
4. Shantakumari N, Eldeeb R, Sreedharan J, et al. Computer use and vision-related problems among university students in ajman, United arab emirate. Ann Med Health Sci Res. 2014; 4(2): 258–263, doi: 10.4103/2141-9248.129058, indexed in Pubmed: 24761249.
5. Amirul FZ, Aqilah R, Lee ML, et al. Knowledge, Attitude and Practice of Computer Vision Syndrome among Staffs that use Video Display Terminal in a Faculty of aMalaysian Public University. Intl J Public Health Clin Sci. 2015; 2(1): 2289–7577.
6. Mowatt L, Gordon C, Santosh AB, et al. Computer vision syndrome and ergonomic practices among undergraduate university students. Int J Clin Pract. 2018; 72(1), doi: 10.1111/ijcp.13035, indexed in Pubmed: 28980750.
7. Logaraj M, Madhupriya V, Hegde Sk. Computer vision syndrome and associated factors among medical and engineering students in chennai. Ann Med Health Sci Res. 2014; 4(2): 179–185, doi: 10.4103/2141-9248.129028, indexed in Pubmed: 24761234.
8. Reddy SC, Low CK, Lim YP, et al. Computer vision syndrome: a study of knowledge and practices in university students. Nepal J Ophthalmol. 2013; 5(2): 161–168, doi: 10.3126/nepjoph.v5i2.8707, indexed in Pubmed: 24172549.
9. Dios JRMd, Arrue BC, Ollero A, et al. Computer vision techniques for forest fire perception. Image Vision Comp. 2008; 26(4): 550–562, doi: 10.1016/j.imavis.2007.07.002.
10. Singh H, Tigga M, Laad S, et al. Prevention of Ocular Morbidity among Medical Students by Prevalence Assessment of Asthenopia and its Risk Factors. J Evidence Based Medicine and Healthcare. 2016; 3(15): 532–536, doi: 10.18410/jebmh/2016/122.
11. Noreen K, Batool Z, Fatima T, et al. Prevalence of Computer Vision Syndrome andilts Associated Risk Factors among Under Graduate Medical Students. Pak J Ophthalmol. 2016; 140.
12. Muma S, Aduda D, Onyango P. Uptake of conventional interventions, level of awareness and perception on computer vision syndrome: a cross-sectional study among University students, Kenya. Ophthalmol J. 2021; 6(0): 1–9, doi: 10.5603/oj.2021.0001.

13. Hashemi H, Fotouhi A, Yekta A, et al. Global and regional estimates of prevalence of refractive errors: Systematic review and meta-analysis. J Curr Ophthalmol. 2018; 30(1): 3–22, doi: 10.1016/j.joco.2017.08.009, indexed in Pubmed: 29564404.
14. Shrivastava S, Bobhate P. Computer related health problems among software professionals in Mumbai: A cross-sectional study. Int J Health & All Sci. 2012; 1(2): 74, doi: 10.4103/2278-344x.101684.
15. Schaumberg DA, Dana R, Buring JE, et al. Prevalence of dry eye disease among US men: estimates from the Physicians' Health Studies. Arch Ophthalmol. 2009; 127(6): 763–768, doi: 10.1001/archophthalmol.2009.103, indexed in Pubmed: 19506195.
16. Khalaj M, Ebrahimi M, Shojai P, et al. Computer Vision Syndrome in Eleven to Eighteen-Year-Old Students in Qazvin. Biotech Health Sci . 2015; 2(3), doi: 10.17795/bhs-28234.
17. Bali J, Navin N, Thakur BR. Computer vision syndrome: a study of the knowledge, attitudes and practices in Indian ophthalmologists. Indian J Ophthalmol. 2007; 55(4): 289–294, doi: 10.4103/0301-4738.33042, indexed in Pubmed: 17595478.
18. Rosenfield M. Computer vision syndrome: a review of ocular causes and potential treatments. Ophthalmic Physiol Opt. 2011; 31(5): 502–515, doi: 10.1111/j.1475-1313.2011.00834.x, indexed in Pubmed: 21480937.
19. Chendilnathan C, Ramalingam P, Raja A, et al. Cross-sectional questionnaire study of ocular effects among IT professionals who use computers. Int J Med Public Health. 2015; 5(1): 63, doi: 10.4103/2230-8598.151264.
20. Han CC, Liu R, Liu RR, et al. R Prevalence of Asthenopia and its Risk Factors inChinese College Students. Int J Ophthalmol. 2013; 6: 718–722.