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LITERATURE REVIEW Open Access

RISK FACTORS OF COMPUTER VISION SYNDROME: A REVIEW OF OCULAR CAUSES AMONG SCHOOL AND COLLEGE STUDENTS

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Abstract

Introduction: *According to the results of a survey published in 2022, mobile phone users have reached two-thirds (67.1%) of the world population. This number has increased by 1.8% over the past year, which is equivalent to 95 million new mobile users. However, gadgets are often misused and can cause a health problem called Computer Vision Syndrome (CVS). This study aimed to identify risk factors for the occurrence of ocular CVS symptoms among school and college students.* ***Discussion:*** *This study was conducted using the literature review method. The main sources for this study were articles obtained through the selection process by setting inclusion and exclusion criteria. This study showed that from a total of 1,763 articles found, 27 articles met the predetermined criteria. A total of 18 of the 27 articles (66.7%) had college student as respondents, and 24 of the 27 articles used cross-sectional research methods (88.9%). In this study, 16 CVS ocular symptoms were found. The risk factors for CVS were individual characteristics (students aged under 18 years and students aged 18–25 years, and gadget users with contact lenses or glasses), smartphone users, individual habits, and ambient lighting while operating gadgets.* ***Conclusions:*** *This study concludes that students are at risk of experiencing CVS if they do not support gadget use with habits such as implementing rest periods between activities using gadgets.*

INTRODUCTION

Gadgets have been commonly used by communities around the world, and this usage is currently increasing. The increasingly diverse types of gadgets are the result of rapid technological advancement to adapt to human needs. According to the results of a survey published in 2022, mobile phone users have reached two-thirds (67.1%) of the world population. This number has increased by 1.8% over the past year, which is equivalent to 95 million new mobile users (1). However, inappropriate gadget use is prevalent in many communities and may cause health problems, especially with the eyes (2).

The eyes are one of the five senses that are very important for humans. This organ consists of several constituent parts with their respective functions. Some of these parts are the cornea, meibomian glands, cilliary muscle, and the tear film (3). The tear film layer has a thickness of about 7-10 micrometers, with an aqueous layer taking up 90% of its thickness. This layer has multiple functions: to retain moisture in the eye, as a lubricant provider between the eye and eyelids, as an oxygen provider for the epithelial epithelium, removes exfoliated epithelial cells, contains antibacterial substances to prevent eye infection, helps maintain corneal hydration through tonicity changes that occur with evaporation, and maintains visual acuity and eye surface health. Small changes in tear film stability and volume may significantly impact vision quality, especially in contrast sensibility (4).

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CVS, also known as digital eye strain, is a health problem that is increasingly becoming a concern along with increasing gadget use and ease of internet access. CVS is a term for several collections of symptoms related to ocular and vision issues resulting from gadget usage. Some of the recognizable ocular CVS symptoms include eye strain, eye fatigue, eye pain, dryness, excessive watering of the eyes, irritation, blurred vision, slowed focus changes, and double vision. (5). In addition to ocular symptoms, there are also extra ocular symptoms here in after referred to as musculoskeletal disorders (6–8). Other symptoms include sleep disturbances or insomnia, which were reported by research respondents who had used gadgets for two years (9).

According to a survey conducted on internet users aged 18 years and over by the statistics research department in 2022, it was stated that internet users' age distribution around the world in 2021 was 33.8% were aged 25–34 years, followed by those aged 18–24 years (22.8%), 35–44 years (18.6%), 45–54 years (11.9%), 55–64 years (7.3%), and finally those over 65 years (5.5%) (10). Meanwhile, according to a 2018 UNICEF report, as many as 175,000 children were connected to the internet every day for the first time (11). An online survey agency conducted research from 2016 to 2018 on children in 11 countries, identifying 4,733 internet users aged 9–17 years. Thus, it is estimated that one in three children in the world are internet users, and one in three internet users are children under the age of 18 years. The next-mentioned result was that the most popular device among them for accessing the internet was a smartphone (12). Professionals and office workers who use gadgets are familiar with when to stop, especially since they can feel discomfort in their limbs when using gadgets in an improper position at their age. However, this is different for school-age children and students. School-age children or students, especially those who are very young, find it more difficult to determine when they should rest or pause when using gadgets compared to professionals or workers (13). Gadget users can come from all age groups, including children. This phenomenon risks the development of ocular symptoms that arise as a result of several risk factors associated with gadget use. This study was made to identify several risk factors for ocular CVS among school children and college students.

DISCUSSION

CVS denotes a health disorder in human vision caused by staring at a gadget's screen or digital device for a long time. In addition to gadget use duration, other factors were also investigated as risk factors for CVS symptoms such as characteristics and habits, as well as environmental factors. The gadgets' characteristics were also investigated as one of the many independent variables.

The individual habits studied include the gadgets usage in one day in units of hours; frequency of gadgets use in one week; the length of gadget use, referring to the number of years since the user begun using gadgets until the research period; blinking frequency, which refers to the number of times a gadget user blinks while looking at a screen, these points were used to see if there were any changes in blinking before and during gadget use; posture or body position when gadget users operate their devices, specifically whether sitting or lying postures were applied; rest time or how much time respondents took to rest after staring at their digital device screens, this point also intended to investigate how much rest time gadget users take; the use of anti-glare filters, this study wanted to see how many studies discussed the use of this filter to protect gadget users, and the impacts of not using the filter; the distance between the eyes and the screen, this point intended to examine how far the respondent placed gadgets from their eyes when operating them.

Individual characteristics that were risk factors for computer vision syndrome were age, gender, use of visual aids, history of eye problems, and eye surgery profile such as LASIK. This study focused on the literature that had school children and college students as respondents. The sexes studied were male and female. Furthermore, the visual aids referred to in this study consist of tools that serve to help correct refractive errors, such as myopia, hypermetropia, and astigmatism. Additionally, students who had experienced eye illness and surgery (e.g., LASIK) were not included in the study because these variables were the exclusion criteria for determining the sample in all the articles referred to.

Another independent variable was the gadgets' characteristics, which includes the type of gadget and screen brightness. The type in question did not refer to the brand, but the form of the gadget itself (smartphone, laptop, computer, or tablet). The other aspect of this variable was the gadgets' brightness. Gadgets typically have screen brightness that can be adjusted according to the lighting around the user. However, a certain degree of brightness can cause discomfort to the eyes.

The physical environment in this study was the last independent variable and included lighting, temperature, and humidity. The environment in question referred to the conditions around gadget users when operating digital devices. These conditions include adequate lighting, appropriate temperature, and humidity. The temperature and humidity variables were not studied because many of the referenced articles did not examine these two variables.

This study applied the literature review method to meet the research objectives by using secondary data as the main data source. The data were in the form of articles obtained from the selection process based on inclusion and exclusion criteria. Some of the inclusion criteria applied were articles published from outside Indonesia, commonly referred to as international journals; at least indexed by Google Scholar; applied the Sinta 1, 2, and 3 indexes for articles published from within the country; previous research focusing on CVS symptoms, digital eye strains, and influencing factors; and used students as research respondents. The exclusion criteria applied to this study were articles that used the same research method (literature review), were not published in the last five years, used workers as research respondents, had research respondents with a history of any type of eye surgery, and had respondents with a history of eye diseases that had been cured or were still being treated due to systemic disorders.

All data in this study were sourced from databases provided by electronic search engines. That is, the data in this study were obtained by searching for articles that already existed on the internet through the Google search engine. During the literature search, the keywords used were computer vision syndrome, gadget and eye, computer vision syndrome and dry eye, computer vision syndrome and risk factors, digital eye strain, visual display unit, computer vision syndrome and environment, computer vision syndrome on student, and computer vision syndrome and student. During the search for the articles needed, several processes were implemented such as identifying articles based on predetermined keywords, limiting the range of years to 2017 onwards, and skimming titles and abstracts. At this stage, from a total of 395,000 articles on Google Scholar; 20,733 articles on Pubmed; 211,000 on ResearchGate; 1,080 on Cureus; and 10,985 on ARVO Journals; 1,763 articles were found that matched the keywords. Next, the articles were filtered based on full-text availability and open access, in addition to eliminating duplicate articles, which left 194 articles. Then, from the 194 articles collected, the results were narrowed by only taking articles that met the inclusion and exclusion criteria. The final result at this stage yielded a collection of 27 articles, most of which were indexed by Scopus, followed by Google Scholars, and finally Sinta.

The data analysis technique used in this study was adapted from the scoping review method (14). This was carried out through four main activities, namely data reduction and characterization, data synthesis, data display, and data interpretation. Data reduction and characterization were done by collecting, focusing, selecting, eliminating, and organizing data according to their relevance to the required information. This stage produced a summary table related to the results obtained for each variable. The grouping of information related to CVS risk factors and symptoms was also carried out based on previous research. The next step was data synthesis, which was done by comparing and differentiating the information obtained based on CVS risk factors and symptoms that were found. Then, a table was presented containing information related to CVS risk factors and symptoms. It was then observed according to the groupings that had been done previously, along with the synthesis results. Finally, at the data interpretation stage, data were given meaning based on supporting information. The results that had been obtained from previous activities were also explored or refuted. The final results obtained indicated that CVS's ocular symptoms were influenced by several risk factors such as individual characteristics, gadget characteristics, individual habits, and physical environment.

The application of inclusion and exclusion criteria in this study yielded nine articles indexed by Google Scholar (33.3%), eight articles indexed by Q3 (29.6%), six articles indexed by Q2 (22.2%), two articles indexed by Q4 (7.4%), one article indexed by Q1 (3.7%), and one article indexed by Sinta 3 (3.7%). Related methods, measuring tools, and statistical tests used in the previous 27 articles can be seen in Table 1. The articles found used more research respondents with college student status (66.7%) than respondents with school-age student status (33.3%). Furthermore, India was the most-researched location out of a total of 11 countries in the 27 articles found (37%). Most of the articles were published in 2021, with a total of nine articles (33.3%). The majority of articles used cross-sectional research methods (88.9%), followed by cohort (7.4%), and prospective (3.7%).

Individual Characteristics

A total of 27 articles were collected showing several individual characteristics such as gender, age, and use of glasses or contact lenses. In as many as 25

Table 1. Articles Review

Articles and Country	Title	Method, Instrument, Population	Result	Summary
Saudi Arabia (23)	Computer Vision Syndrome Prevalence, Knowledge and Associated Factors among Saudi Arabia University Students: Is it A Serious Problem?	Cross-sectional Questionnaire College student	1. Symptoms that appear are eye strain (62.4%), burning sensation in the eyes (7.57%), eye redness, dryness and irritation of the eyes, watery eyes, and problems focusing 2. A significant association was found between myopia and computer-induced visual symptoms ($p < 0.001$)	Continuous and for a long time use of gadget causes serious vision issues, particularly the computer and other similar devices
Nepal (29)	Knowledge, Attitude and Practice of Computer Vision Syndrome among Medical Students and its Impact on Ocular Morbidity	Cross-sectional Questionnaire, UDVA, refractive error, intraocular pressure measurement, Schirmer test, orthoptic evaluation College student	1. Symptoms that appear are blurry vision, dryness, and watery eyes as well as headaches and eye strain in university students 2. Respondents that use computers more than 2 hours in a day were likely to experiencing CVS ($p = 0.001$) 3. There was a significant relationship between applying rest time ($p = 0.0001$) and blinking frequency ($p=0.0411$) during computer use and relieving CVS symptoms. 4. There is no significant relationship between gender and age with CVS	The survey shows that CVS is relevant among MBBS students, but their knowledge, attitudes and practices about CVS are poor
Pakistan (24)	Prevalence of Computer Vision Symptoms and its Awareness Engineering Students of Twin Cities	Cross-sectional Questionnaire, Snellen Chart College student	1. Symptoms that appear are headaches, and eye strain 2. A significant relationship was found between symptoms of eye fatigue (eye strain, headache, and blurred vision) and eyeglass wearers ($p < 0.05$) 3. Gadget user's posture showed a significant relationship with watery eyes ($p < 0.004$) 4. There is a significant relationship between exposure screen time and CVS symptoms ($p < 0.05$) 5. The use of ophthalmic lubricants has a significant relationship with less symptom frequency 6. The use of glasses/contact lenses as a correction aid has a significant relationship with CVS	As many as 87.7% of university students in Rawalpindi, Islamabad experience symptoms related to CVS, which is often seen in computer users with a duration of more than 2–3 hours continuously every day with wrong posture
Egypt (39)	Computer Vision Syndrome Survey among the Medical Students in Sohag University Hospital, Egypt	Cross-sectional Questionnaire College student	1. Symptoms found in this study were headache (26%), eye fatigue (21%), dry eyes (28%), blurred vision (31%), eye strain (16%), double vision (1%), red eyes and eye irritation (15%), and difficulty in refocusing (8%) 2. It was found that smartphones were generally the main cause of CVS in college students 3. The initial manifestation of CVS is when using a digital screen for 3 hours per day regularly	This study reported the most prevalent symptoms of CVS were blurry eyesight, eye strain, dryness, and headache. As many as 86% of medical students in this study complained of one or more manifestations of CVS
India (40)	Does Digital Screen Exposure Cause Dry Eye?	Cross-sectional Questionnaire, Schirmer test, TBUT, ocular surface dye staining College student	1. Symptoms that appear are fatigue or eye strain, blurry vision, headache, red and excessive watering of the eyes, double vision 2. The duration of gadget use has a significant relationship with the presence of dry eyes ($p = 0.003$)	There are number of steps that can help protect eyes from the harmfull effects of technology such as changing viewing distance to objects other than the gaget screen, lowering the brightness of the device's screen, and intentionally increasing blink rate
India (35)	Visual Implications of Digital Device Usage in School Children: A Cross-Sectional Study	Cross-sectional Questionnaire, Torchlight School student	1. Symptoms that appear are eye strain and prescription changes in eyeglass lenses 2. Distance when students are reading influences the number of symptoms suffered by digital device users 3. Time spent using devices increased significantly with age ($p < 0.001$) 4. Increasing age is significantly associated with increased weekly device usage ($p < 0.001$) 5. Smartphone use increases significantly as students get older ($p < 0.001$)	An increasing digital devices usage by young people brings new challenges in the form of digital eye fatigue at a young age. This research reports patterns of gadget use among schoolchildren, assesses factors associated with eye fatigue, and affirms the need for further probe on this issue
India (30)	An Evaluation of Prevalence and Risk Factors of Computer Related Ocular Problems Among Engineering Students of Bangalore	Cross-sectional Questionnaire College student	1. Symptoms that appear: headache, eyestrain, blurry eyesight, dryness, tearing, redness 2. Computer use >6 hours more risky than who use <6 hours ($p < 0.01$)	Extensive computer use is associated with a very worrying incidence of visual impairment and other health problems. There needs to be great attention to CVS from health and education professionals to adopt preventive measures as a measure to tackle this global health problem

Articles and Country	Title	Method, Instrument, Population	Result	Summary
Saudi Arabia (6)	Computer Vision Syndrome among Male and Female Medical Students in King Saud bin Abdulaziz University, Riyadh	Cross-sectional Questionnaire College student	1. Symptoms reported by the students were headache, double vision, watery eyes, redness, eye pain, burning sensation, itching, dryness, sensitivity to light, worsening vision, blurred vision, difficulty in focusing, foreign body sensation, excessive blinking, seeing halos, and heavy eyes 2. Females feel the impact of CVS more than males ($p = 0.044$) 3. The learning method of participants who use electronic devices has a significantly more significant effect on CVS than participants who use hardcopy ($p = 0.032$)	Learning through electronic methods leads to an increased incidence of CVS, and women who use these electronic methods have a higher chance of developing CVS
Saudi Arabia (15)	Computer Vision Syndrome among Undergraduate Medical Students in King Abdulaziz University, Jeddah, Saudi Arabia	Cross sectional Questionnaire College student	1. Reported eye symptoms include excessive tearing, dryness, more sensitive to light, itching, redness, burning, sore eyes, foreign body sensation, blurry eyesight, color vision changes, diplopia, and headaches 2. Female participants were risky than male ($p = 0.003$) 3. Although the existence of refraction mistakes such as myopia and hyperopia was not associated with CVS ($p = 0.03$), astigmatism was significantly associated with CVS, especially related to headache and photosensitivity ($p = 0.001$) and ($p = 0.01$) 4. The use of glasses or contact lenses to correct vision during learning activities does not show a significant relationship 5. The most important risk factors were learning time ($p \leq 0.001$), distance from the screen ($p < 0.05$), and screen brightness ($p < 0.05$) 6. Participants who did not rest during learning activities were significantly associated with lacrimation, diplopia, and visual colour changes ($p < 0.05$) 7. Posture during learning activities is not related to any CVS symptoms 8. Screen position at eye level or higher was significantly related to elevated photosensitivity, double vision and visual discoloration ($p < 0.05$) 9. Participants studying in dark room with window lighting, table lamps, and screen lighting were significantly associated with blurry vision, redness, foreign body sensation in the eyes, diplopia, and visual colour changes ($p < 0.05$) 10. Brighter screens are more sensitive to light ($p < 0.01$) 11. A great number of students not using screen filters were significantly correlated with itchy eyes, double vision, and discolouration of vision ($p < 0.05$) 12. The effect of precautions such as the application of the triple 20 instruction was extremely significant precautions ($p = 0.01$), engaged by appropriate screen placement ($p = 0.04$), while other preventive measures did not show a significant relationship significant	CVS is widespread among medical college students. Significant risk factors must be addressed to reduce symptoms and improve productivity. There is also a need to educate medical students about computer-related health issues
India (41)	Impact of the Covid19 Lockdown on Digital Device-Related Ocular Health	Cross sectional Questionnaire College student	1. Symptoms obtained from the respondent's report are headache, sore eye, heavy eyelids, redness, tearing, burning, dryness, light sensitivity, itching, excessive blinking, inability to concentrate on printing text, blurry eyesight, decreased vision, foreign body sensation, double vision, halos around bright objects 2. Gender differences between men and women had a statistically significant relationship with CVS symptoms ($p = 0.009$) 3. A significant correlation was found between increased the duration and the amount of CVS symptoms ($p = 0.001$) 4. The frequency of symptoms increased statistically and significantly with increasing screen time ($p = 0.028$) 5. Increased screen time also significantly increased symptom intensity ($p = 0.005$)	After the start of Covid19 lockdowns, the use of digital devices has increased dramatically, deteriorating eye health across all age groups. Awareness to prevent digital eye strain should be emphasized and future measures to minimize this side effect should be considered
Saudi Arabia (16)	Computer Vision Syndrome Among Health Sciences Students in Saudi Arabia: Prevalence and Risk Factors	Cross sectional Questionnaire College student	1. Symptoms reported by the students were headache, itching, burning sensation, watery eyes, blurred vision, red eyes, dryness, sensitivity to light, pain around the eyes, foreign body sensation, excessive blinking, difficulty focusing for near vision, halos around objects, diplopia, difficulty in moving the eyelids 2. The amount of eye signs was significantly higher in female students ($p = 0.002$), spectacle wearers ($p = 0.002$), and who see glare on the screen ($p = 0.004$) 3. Ergonomics practice was not connected with a decrease in the amount of symptoms ($p = 0.947$) 4. CVS symptoms enhancement is not affected by prolonged gadget use ($p = 0.689$)	Symptoms of CVS are usually mentioned with the aid of using fitness technological know-how college students who use a number of digital devices, have a look at display screen glare, and put on eyeglasses. Long-time period use of the tool changed into now no longer extensively related to expanded CVS symptoms

Articles and Country	Title	Method, Instrument, Population	Result	Summary
China (42)	Computer Vision Syndrome during SARS-CoV-2 Outbreak in University Students: A Comparison Between Online Courses and Classroom Lectures	Cross-sectional Questionnaire College student	1. Some of the symptoms resulting from this study were heavy eyelids, dryness, foreign body sensation, headache, eye pain, blurred vision, watery eyes, excessive blinking, feeling that vision was worsening, difficulty seeing near objects, itching, burning sensation, light sensitivity increased, double vision, redness of the eyes, and halos around objects 2. Prevalence of CVS in offline and online students respectively was 74.32% and 50.79% ($p = 0.004$) 3. Time spent using digital screens was weakly positively correlated with strange body feeling ($p = 0.01$), eyelid heaviness ($p = 0.016$), and eye dryness ($p = 0.007$) 4. Total CVS values were moderately positively correlated with visual display screen time ($p < 0.001$)	Online learning helps spread CVS among college students
India (21)	Digital Eye Strain Epidemic amid Covid19 Pandemic – A Cross-sectional Survey	Cross-sectional Questionnaire College student	1. Students who took online courses had the highest digital eye strain (DES) scores than any other group ($p \leq 0.0001$) 2. Age was negatively correlated with DES scores because gadget usage is inversely proportional to age ($p = 0.0001$) 3. DES scores were higher for respondents with longer screen time ($p \leq 0.0001$) 4. DES scores were also found to be higher in respondents with a screen distance of < 20 cm ($p = 0.002$) 5. The DES score was reported to be higher in respondents using digital devices with the lights off ($p = 0.017$) 6. The DES score was stated to be higher for respondents without rest time/ rarely ($p = 0.018$) 7. The number of DES is unconnected wiith amount of daily gadget usage ($p = 0.19$)	The public should be educated to limit general screen show and ergonomic screen viewing practices. To curb the eye strain epidemic, policy makers should strive to shorten the duration of online courses
India (22)	Impact of E-Schooling on Digital Eye Strain in Coronavirus Disease Era: A Survey of 654 students	Cross-sectional Questionnaire School student	1. Symptoms of CVS include blurry vision, burning sensation, straining eye, excessive blinking, stinging feeling in the eyes, sensitivity to light, redness of the eyes, eye pain, heavy eyes, difficulty in focusing, heavy eyelids, and dry eyes 2. The average age of children with eye fatigue was 12.3 ± 3.8 years, while children with an average age of younger (7.4 ± 2.1 years) were known to be without eye fatigue ($p < 0.001$) 3. The duration of exposure to digital devices did not indicate eye fatigue experienced by children ($p = 0.001$) 4. Eyeglass users did not report feeling tired eyes, but respondents who were not eyeglass users reported eye fatigue ($p = 0.002$) 5. There was a significant difference in CVS scores in different duration groups ($p < 0.001$) 6. There change into no widespread distinction in CVS rankings among boys or girls. ($p = 0.61$) 7. The average CVS score for eyeglass users was different from that for children without glasses ($p = 0.009$) 8. There is a significant difference in CVS scores between age groups. CVS scores were higher in the >16 year age group ($p < 0.001$) 9. There is a significant difference in CVS scores between class groups. Lower CVS scores were found in the grade 1–5 group compared to the grade 10–12 group ($p < 0.001$). Significant differences were also found in CVS scores between the 6–9 and 10–12 grade groups ($p < 0.001$)	Majority of surveyed scholars had as a minimum one sign whether dry eye or eye strain. This shows the importance of educational needs regarding the possible detrimental effects on them and helps in adapting to the current evolving education system
Egypt (9)	Visual Sequelae of Computer Vision Syndrome: A Cross-Sectional Case-Control Study	Cross-sectional Questionnaire, UDVA, CDVA, subjective and cycloplegic refraction, ocular movement test, slit lamp examination, measurement of intraocular pressure, pupillary reflexes, fundus examination, TBUT, Schirmer test, mfERG examination College student	1. Ocular symptoms such as blurry ($p < 0.0001$), dry eyes ($p = 0.02$), eye strain ($p < 0.0001$), redness ($p = 0.002$), difficult refocusing ($p = 0.02$), near vision difficulties ($p = 0.04$), and unclear objects ($p < 0.0001$) were found to be significantly higher in students who used smartphone-type gadgets compared to laptop and desktop computers 2. Ocular symptoms worsened with increasing daily screen time (hours) (OR = 2.0; $p < 0.0001$) 3. Ocular symptoms worsened with increasing number of screen time in one year (OR = 1.2; $p < 0.0001$) except for tension ($p = 0.1$) and eye redness ($p = 0.94$) 4. The screen brightness level does not show a big difference to the screen mode ($p = 0.6$) such as intermittent or continuous use ($p = 0.14$) and the symptoms complained of by students 5. Based on the results of the final logistic regression analysis, inadequate viewing distance to the eyescreen, inappropriate viewing angles, inadequate screen pattern, bad screen prescription, improper sitting gesture, and refractive errors were concluded to be the main risk factors for CVS ($p < 0.0001$) 6. Recent linear regression analysis results indicate that, in addition to poor lighting conditions, small screen and font size are the main factors influencing the number of CVS-realted symptoms and complaints ($p < 0.0001$) 7. It was found that students who spend more than 3 hours per day staring at gadget screens ($p = 0.006$), spending most of the night in front of a screen ($p = 0.03$), and adjusting screen lighting >50% ($p = 0.01$) likely to cause changes in mfERG	This study helps identify risky subjects which need fully screened to confirm or rule out a diagnosis of CVS. Especially mobilephone abuse causes CVS amongst users

Articles and Country	Title	Method, Instrument, Population	Result	Summary
Bangladesh (27)	Prevalence and Impact of the Use of Electronic Gadgets on the Health of Children in Secondary Schools in Bangladesh: A Cross-Sectional Study	Cross-sectional Questionnaire School student	1. The reported symptoms of CVS are headache and visual disturbances 2. Most participants in both secondary schools i.e. Bangla and English use gadgets whereas most participants in Madrasha do not ($p < 0.001$) 3. A sample of slow growth in gadget usage ($p = 0.0002$) become determined amongst contibutors dwelling in rural, suburban, and concrete areas 4. Participants who hung out from the device (0–1 hours) had been discovered to be healthier and drastically much less in all likelihood to increase fitness complication ($p < 0.05$) 5. Physical problems such as headaches (Odd Ratio = 2.41 for gadget use >6 hours), visual impairment (Odd Ratio = 2.384 for 4-6 hours gadget use), and sleep disturbances (Odd Ratio = 5.988 for gadget use > 6 hours) categorized as physical problems that occur regularly 6. Participants who use gadgets for 4–6 hours and >6 hours are more at risk of experiencing dizziness than participants who do now no longer use gadgets (0–1 hour)	This research shows that various sociodemographic elements affect children's device use and this use has a significant impact on the mental and physical health of junior high school students in Bangladesh
India (20)	Prevalence and Risk Factor Assessment of Digital Eye Strain among Children using Online E-Learning during the Covid19 Pandemic: Digital Eye Strain Among Kids (DESK Study - 1)	Cross-sectional Questionnaire School student	1. Some of the symptoms of CVS reported by students were itching, headache, double vision, seeing halos around objects, feeling that vision was worsening, increased sensitivity to light, difficulty in focusing on near targets, blurry vision, dryness of the eyes, drooping eyelids. heaviness, eye pain, redness, excessive blinking, watery eyes, foreign body sensation, burning sensation 2. The average duration of using gadgets during the Covid19 longer than the pre-Covid19 period ($p \leq 0.0001$) 3. The results of the univariate analysis stated that DES was significantly associated with male sex (OR = 1.59; $p < 0.0004$) 4. The results of the univariate analysis stated that DES was significantly related to smartphone use (OR = 1.98; $p = 0.01$) 5. The results of the univariate analysis stated that DES was significantly related to the duration of using digital devices >5 hours (OR = 3.38; $p < 0.0001$) 6. The results of the univariate analysis indicated that DES had huge affiliation with virtual gadgets at distances less than 18 inches (OR = 1.65; $p = 0.09$) 7. The results of the univariate analysis stated that DES was significantly associated with mobile game playing activities >1 hour per day (OR = 16.69; $p < 0.0001$) 8. The results of multivariate analysis stated that age 14 years or older (OR = 2.17; $p = 0.04$), male (OR = 4.2; $p = 0.0004$), digital device use more than 5 hours (OR = 3.6; $p = 0.0007$), use of mobile games more than 1 hour per day (OR = 8.1; $p = 0.0001$), and preference for mobilephones over different virtual devices (OR = 3.2; $p = 0.003$) was an impartial hazard element for DES in children	The prevalence of digital eye strain (DES) in children is increasing during the Covid19 era. Parents should pay attention to the length, kind and range of gadget usage to prevent the phenomenon
Turkey (36)	Digital Eye Strain and its Associated Factors in Children During the Covid19 Pandemic	Cross-sectional Questionnaire School student	1. Symptoms of acquired CVS are headache, eye fatigue, redness, eye pain, watery eyes, foreign frame sensation, blurry and double eyesight 2. Use of visual gadgets for greater than three hours consistent with day turned into a good sized hazard element for dizziness ($p < 0.001$) 3. The use of display equipment greater than 4 hours in a day is considerably related to sore eye ($p = 0.027$), foreign body sensation ($p = 0.003$), and watery eyes ($p = 0.03$) 4. Spending 5 hours per day operating display devices was identified as a considerable danger issue for eye pressure ($p \leq 0.001$) and redness ($p \leq 0.001$) 5. Staring at a screen for 35 minutes with no rest was an important hazard element for dizziness ($p = 0.001$) 6. Significant connections have been additionally determined while consuming more than eighty mins staring at display device without pause/rest with eye pain ($p = 0.045$) 7. Preferring to use smartphones for online learning has a significant relationship in sore eye and blurry eyesight 8. Gadgets usage for entertainment in dark environments is meaningfully related with sore eye, dizzy, eye frazzle, redness, tearing 9. High display brightness indicates important connection with eyeache and strange body sensation 10. Display spacing of less than fourty centimeters has a significant relationship with eye fatigue 11. Multivariate evaluation confirmed that male ($p = 0.005$) and being old ($p = 0.001$) had been unbiased chance elements to have three or extra types of signs 12. Factitious illumination exhibited a substansial intercourse with sore eye ($p = 0.005$), eye weariness ($p = 0.013$), red eyes ($p = 0.013$), and watery ($p = 0.014$)	The growing use of virtual gadgets with the aid of using kids exacerbates the hassle of virtual eye stress in kids as a facet impact of online studying. There is a need to increase public awareness

of the 27 articles that differentiated respondents' gender, 12 articles (48%) had more female respondents than male respondents, 11 other articles (44%) had more male respondents than female respondents, and the remaining two articles (8%) examined respondents with the same gender distribution. In addition, in the 27 articles found, the youngest gadget user was five years old and the oldest was around 27 years old. Visual aids in the form of contact lenses and glasses to correct refractive errors were studied by 15 articles (55.5%), while the other 12 articles did not examine them.

Individual Habits

According to the results of the study on individual habits depicted in Table 2, it was found that 24 out of 27 articles (88.9%) examined the duration of gadget operation in one day. The duration was classified into different groups, namely less than two hours, two to four hours, and more than four hours. The over four hours per day category was the most prevalent across the compiled articles (62.5%). Some of the gadgets that were used most often in daily activities were laptops/desktops, tablets, and smartphones. Weekly gadget use of was only mentioned in two out of 27 articles (7.4%). Meanwhile, the duration of gadget use in years was only found in three research articles (11.1%).

In addition to the duration of gadget use, other individual habits found from 27 articles were blinking frequency observed in three articles (11.1%), posture/body position found in five articles (18.5%), and pause/rest time in 12 articles (44.4%), use of anti-glare filters in three articles (11.1%), the distance between gadget screens and eyes in nine articles (33.3%), and gadget screen brightness in six articles (22.2%). The explanation previously mentioned regarding individual habits when using gadgets is shown in Table 2.

Physical Environment

According to the results of the study shown in Table 3, seven out of 27 articles (26%) examined the

Table 2. Individual Habits When Operating Gadget

Article	Duration Per Day			Frequency in one week	Usage time (year)	Blinking Frequency (n) (%)	Body Position/ Posture (n) (%)	Breaktime (n) (%)	Use of Filter (n) (%)	Distance (n) (%)	Screen Brightness (n) (%)	N
	< 2 hour (n) (%)	2-4 hour (n) (%)	> 4 hour (n) (%)									
(23)	-	32 (5.0)	602 (95)	-	-	-	-	-	-	-	-	634
(29)	73 (31)	127 (53.9)	39 (16.6)	-	-	Often = 34 (14.4%)	-	141 (60%)	-	Above eye level = 176 (75%) Below eye level = 60 (25.4%)	-	236
(24)	-	91 (26)	259 (74)	-	-	Often = 67 (19.1%)	False = 237 (67.8%) True = 113 (32.3%)	140 (40%)	Use = 21 (6%)	-	-	350
(43)	26 (26)	42 (42)	32 (32)	-	-	-	-	-	-	-	-	100
(39)	14 (14)	45 (45)	41 (41)	-	≥3 years	-	-	-	-	-	≤10% = 5 (5%) 11–25% = 26 (26%) 26–50% = 33 (33%) 51–75% = 28 (28%) 76–100% = 8 (8%)	100
(40)	52 (57.8)	24 (26.7)	14 (15.6)	-	-	-	-	72 (80%)	-	-	-	90
(44)	41 (16.4)	65 (26)	144 (57.6)	-	-	-	-	-	-	-	-	250
(45)	156 (33.7)	307 (66.3)		-	-	-	-	-	-	-	-	463
(35)	224 (38.9)	251 (43.6)	101 (17.5)	1–2 times = 87 (15.1%) 3–4 times = 138 (24%) 5–6 times = 73 (12.7%) Everyday = 278 (48.3%)	-	-	Sitting = 445 (77.3%) Lying on the bed = 123 (21.4%) Both = 8 (1.4%)	-	-	<25 cm = 96 (16.7%) 25–40 cm = 322 (56%) Along the arm = 158 (27.4%)	-	576

Article	Duration Per Day			Frequency in one week	Usage time (year)	Blinking Frequency (n) (%)	Body Position/ Posture (n) (%)	Breaktime (n) (%)	Use of Filter (n) (%)	Distance (n) (%)	Screen Brightness (n) (%)	N
	< 2 hour (n) (%)	2-4 hour (n) (%)	> 4 hour (n) (%)									
(46)	25 (25)	66 (66)	9 (9)	-	-	-	-	-	-	-	-	100
(37)	27 (45)	33 (55)		-	-	-	-	-	-	10–20 cm = 23 (38.3%) 20–40 cm = 47 (78.3%)	Low = 36 (60%) Medium = 18 (30%) High = 6 (10%)	60
(30)	20 (2)	90 (9)	890 (89)	-	-	-	-	560 (56%)	-	-	-	1000
(15)	113 (19.3)	202 (34.4)	272 (46.3)	-	-	Infrequently/ never = 320 (54.5%) Often = 110 (18.7%) Always/very often = 157 (26.7%)	Sitting = 248 (42.2%) Lay down = 21 (3.6%) Both = 318 (54.2%)	506 (86.2%)	Use = 77 (13.1%) Do not use = 510 (86.9%)	<forearm length = 381 (65%) >forearm length = 206 (35.1%)	Low/dark = 223 (38%) Bright =226 (38.5%) Very bright = 98 (16.7%)	587
(41)	17 (4.2)	67 (16.5)	323 (79.4)	-	-	-	-	77 (19%)	-	-	-	407
(16)	-	-	334 (100)	-	-	-	Sitting = 197 (59%)	220 (65.9%)	Use = 53 (15.9%)	Face height = 197 (59%) The top of the screen is at eye level = 144 (43.1%) >50 cm = 107 (32%)	Adjusting to ambient light = 274 (82%)	334
(42)	3 (2.2)	33 (24)	101 (73.7)	-	-	-	-	-	-	-	-	137
(21)	22 (3.2)	118 (17.2)	548 (79.7)	-	-	-	-	Often = 203 (30%) Infrequently = 124 (18%)	-	<20 cm = 98 (14.2) 20–37 cm = 672 (97.7) >37 cm = 171 (24.9)		688
(22)	269 (41.1)		385 (58.9)	-	-	-	-	-	-	-	-	654
(9)	-	733 (100)		-	2.8–6.6 years	-	Sitting = 79 (10.8%)	579 (79%)	-	Near = 312 (42.6%)	20–66.6% = 176 (24%) 14.7–63.7% = 557 (76%)	733
(47)	-	-	1,237 (100)	Before Covid19 = 6.2 hours During Covid19 = 19.8 hours	-	-	-	-	-	-	-	1,237
(27)	608 (33.7)	956 (53)	239 (13.3)	-	-	-	-	-	-	-	-	1,803
(20)	137 (63.1)		80 (36.9)	-	-	-	-	-	-	<18 inch (45.72 cm) = 66 (30.4%) >18 inch (45.72 cm) = 143 (65.9%)	-	217

<table>
<tr><th rowspan="2">Article</th><th colspan="3">Duration Per Day</th><th rowspan="2">Frequency in one week</th><th rowspan="2">Usage time (year)</th><th rowspan="2">Blinking Frequency (n) (%)</th><th rowspan="2">Body Position/ Posture (n) (%)</th><th rowspan="2">Breaktime (n) (%)</th><th rowspan="2">Use of Filter (n) (%)</th><th rowspan="2">Distance (n) (%)</th><th rowspan="2">Screen Brightness (n) (%)</th><th rowspan="2">N</th></tr>
<tr><th>< 2 hour (n) (%)</th><th>2-4 hour (n) (%)</th><th>> 4 hour (n) (%)</th></tr>
<tr><td>(48)</td><td>21
(5.5)</td><td>73
(19.1)</td><td>288
(75.4)</td><td>-</td><td><1 year = 41 (10.7%)
1-<2 years = 53 (13.9%)
2-<3 years = 87 (22.8%)
3-<4 years = 60 (15.7%)
≥4 years = 139 (36.4%)</td><td>-</td><td>-</td><td>244
(63.9%)</td><td>-</td><td>-</td><td>-</td><td>382</td></tr>
<tr><td>(36)</td><td colspan="2">262
(37.9)</td><td>430
(62.1)</td><td>-</td><td>-</td><td>-</td><td>-</td><td>135
(19.5%)</td><td>-</td><td><40 cm = 312 (45.1%)
>40 cm = 380 (54.9%)</td><td>Low = 53 (7.7%)
Medium = 600 (86.7%)
High = 39 (5.6%)</td><td>692</td></tr>
<tr><td>(49)</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>244
(46.8%)</td><td>-</td><td>-</td><td>-</td><td>521</td></tr>
</table>

(-) = No information found in the article

lighting around gadget users while staring at digital screens. There were differences in categorizing lighting between some researchers. A total of two out of seven articles (28.6%) categorized lighting into good and bad, two articles (28.6%) categorized it into dark and light rooms, with the remaining three articles (42.9%) categorizing based on the light source (natural and artificial).

Table 3. Physical Environment

Article	Types of Lighting and Its Users	Total
(29)	Artificial light (lamp) = 197 Natural light = 39	236
(35)	Dark/lights off = 111	111
(37)	Good = 52 Poor = 8	60
(15)	Roof/Wall = 479 Other sources (window, desk lamp, or dark room) = 108	587
(21)	Dark room = 782 Bright room = 160	942
(9)	Poor lighting = 153	153
(36)	Natural light = 394 Artificial light = 298	692

CVS Symptoms

A total of 16 ocular CVS symptoms could be found in the 27 articles. The 16 symptoms were headache, pain or soreness in the eyes, red eyes, watery eyes, burnt sensation, dry eyes, increased light sensitivity, itching, heavy eyelids, excessive blinking, blurry eyesight, worsening vision, foreign body sensation, double vision, halos around bright objects, and difficulty focusing on printed text (6).

Risk Factors for Ocular CVS Symptoms

Referring to the results of the study attached to Table 1 regarding the article review, several studies stated that female respondents had a higher risk of experiencing ocular CVS symptoms compared to men (6,15–16). These results were supported by research from a university in Ethiopia in 2021 which stated that the likelihood of developing CVS in women was almost three times higher than in men (17). This difference was expressed in a book which suggested that the balance of androgen/estrogen hormones had an impact on the meibomian gland function and resulted in reduced tear secretion (18). More specifically, a study explained that lower androgen and higher estrogen in a person encouraged meibomian gland dysfunction, which ultimately resulted in dry eyes (19).

According to an article published in India in 2021, being older than 14 years old was one of the higher risk factors for Digital Eye Strain (DES) symptoms in students (20). One study stated that age had a negative correlation with DES scores. This can be explained as the duration of gadget use decreases by age; therefore, high DES scores were more commonly found in age groups younger than 33 years (21). Similar results were described by an article examining the impact of e-schooling with DES in the Covid19 era for school-age children in India in 2020. The study found that students younger than five did not experience CVS symptoms, while the older age group had higher CVS scores (22). Because this study focuses on ocular CVS ocular experienced by school and college students, the age range identified was around 5-27 years.

Glasses or contact lenses used to assist gadget users in correcting refractive errors had a significant relationship with ocular CVS symptoms, as can be seen in Table 1 regarding the article review (16,23–24). This is supported by research on students in Saudi Arabia in 2021 which explained that the high frequency of contact lens usage resulted in high dry eye intensity and frequency in students (25). The results of a study conducted at a university in Saudi Arabia reported that the most severe and common CVS symptoms were found in students with refractive errors (myopia) who corrected the condition using contact lenses (23). Beside contact lenses, glasses use to correct refractive errors has also resulted in reports of CVS symptoms in students, namely eye strain (26). This was also explained in a study conducted on university students in Saudi Arabia in 2020 where students with astigmatism showed CVS symptoms, especially headaches and increased light sensitivity (15).

The smartphone is a type of gadget that is widely used by both school and college students (1,12,27). This type of gadget had the highest severity of symptoms compared to other types of gadgets such as tablets, laptops, and desktop monitors. This can be attributed to phones' smaller screen size, which can lead to the increasing severity of symptoms, especially eye strain, fatigue, and lack of focus (9). A brief explanation of how gadget use can affect CVS is mentioned by a study that stated the writing or letters on the gadget screen are formed from very many small dots (pixels). These pixels form a letter or image with a lighter center and less defined edges. As a result, eyes with perfect function (without refractive errors) have difficulty maintaining focus when looking at the gadget screen (28).

Table 2 on several individual habits shows duration was classified into different groups, namely less than two hours per day, twoto four hours per day, and more than hours in a day. In that table, it can be seen that the articles with respondents who mostly operated gadgets for over four hours per day dominated this category. The results of the analysis between the duration of gadget use per day with ocular CVS symptom reports are shown in Table 1. Continuous use of computers for over hours was reported to result in the emergence of CVS symptoms in students (29). Another article stated that students who used gadgets for more than six hours daily had a higher risk of experiencing CVS symptoms than those who used them for less than six hours (30). The increasing duration of gadget use has had an impact on students' ocular health, which is evident in spikes in refractive errors, eye fatigue, headaches, watery eyes, increased light sensitivity, itchy eyes, temporary blurry vision, eye dryness, red eyes, gritty eye sensation, and temporary double vision (31).

Table 2 shows that only three of the 27 articles discussed blinking frequency. The three articles are detailed in Table 1. The number of blinks with continuous smartphone use generally decreased and caused problems related to dry eyes (20). Another study stated that blinking more frequently while using gadgets was able to relieve ocular CVS symptoms (29). However, different results were discovered in research at a Saudi Arabian University in 2020. A significant relationship between blinking frequency when using a gadget and CVS was not found by the researchers (15). This statement is in line with research conducted on patients at the Singapore National Eye Center Dry Eye Clinic in 2012, which found that watching television can reduce the rate of blinking. This led to higher tear evaporation and tear film instability as well as reports of blurred vision by the patient (32).

The most common posture or position of a person's body when operating a gadget was found to be sitting (Table 2). Table 1 shows that from the five articles that examined students' posture or position using gadgets, only three analyzed the relationship between posture and ocular CVS symptoms. The study at a university in Saudi Arabia in 2020 did not find any relationship between students' posture or position when staring at a gadget with any CVS symptoms (15). However, different findings were reported in a study conducted on 733 medical students at an Egyptian university in 2021. This study claimed that improper sitting position was one of the main risk factors for CVS symptoms (9). Similar results were found in studies with respondents working as secretaries in Ethiopia in 2020. This article stated that improper sitting positions can cause ocular CVS symptoms (33).

Table 2 also shows data on the individual habit of pause or rest time between gadget usage. This table shows that as many as 12 out of 27 articles researched respondents' pause/rest time. Almost all studies categorized pause/rest time numerically, except for one study that divided answers into frequent and infrequent. Those who took a break every 15/30/60 minutes fell into the frequent category, and those took a break every 2-3 hours were categorized as rarely resting. The article also featured the results of a CVS symptom risk factor analysis, which found that the highest DES score was caused by not or rarely taking rest time when looking at gadget screens (21). Furthermore, the relationship analysis between rest time and ocular CVS symptoms can also be found in Table 1. An article stated that resting frequency did not have a significant relationship with CVS. However, those who did not take time to rest between learning activities using gadgets were significantly associated with double eyesight, watery eyes, and changes when visualizing colors (15). Another analysis from a university in Pakistan in 2018 found that most respondents had good knowledge about time off/rest as a preventive measure to relieve CVS symptoms, and applied this understanding when working at a computer (24). A subsequent article examined knowledge, attitudes, and practices related to CVS in medical students as well as their impact. It was reported that taking a break while operating a computer can relieve CVS symptoms (29). The same analysis results were also shown in a study with engineering students as respondents at a university in Bangalore, India in 2020 (30). Eye symptoms such as stinging, burning, and redness were found in a higher percentage of students who rarely applied time off when using gadgets (22). A study on students at a university in Saudi Arabia in 2020 showed the impact of the 20-20-20 rule on CVS symptoms. This means that students who rarely or never applied the 20-20-20 rule when using gadgets reported CVS symptoms (15). The 20-20-20 rule in question is that for every 20 minutes a gadget user looks at the screen, they must rest for 20 seconds to look at an object that is 20 feet or about 6 meters away (13). In contrast to several previous statements, research conducted on students at a university in Spain in 2020 showed that scheduled rest periods during work using gadgets did not affect CVS prevalence (34).

Anti-glare filters on computers can effectively reduce glare and reflections, which in turn can minimize ocular issues including eye fatigue, difficulty focusing, itching, watery eyes, and dry eyes (34). A study titled "Risk Factor of Computer Vision Syndrome: A Review of Ocular Causes Among School and College Students" found several articles (three out of 27) that examined the use of anti-glare or anti-radiation filters on gadget screens. Out of all the articles studied, only one article was found that analyzed the filter use and ocular CVS symptoms. The article came from the journal of ophthalmology, and it was a study on a total of 651 medical students from a university in Saudi Arabia in 2020. The majority of respondents did not have the habit of using anti-glare or anti-radiation filters, and no relationship was found between these habits and CVS symptoms (15). However, a different statement emerged from Ethiopia in 2020. This article identified a relationship between anti-glare filter usage and CVS. The researchers clearly explained that secretaries who used anti-glare filters were 78.4% less likely to develop CVS compared to those who did not use on-screen filters (33).

As shown in Table 2 on individual habits, nine out of 27 articles examined the screen distance from the gadget user's eyes. However, Table 1 on article reviews only shows six articles that examined the relationship between eye distance and screen with ocular CVS symptoms. According to research conducted on grade 12 students at a private school in India, the optimal screen distance for writing and reading activities is between 30 to 40 cm away from the user's eye. Meanwhile, when using a smartphone with a smaller screen size than a computer, the distance between the eyes and the screen was generally around 20-30 cm, thus encouraging eye strain (35). Similar to the previous article, a study conducted in India between April and July 2020 found that gadget users with a screen distance of less than 20 cm from their eyes had a higher CVS score (21). Specifically, gadget users with improper visibility could experience ocular symptoms such as blurry vision, poor eye coordination and focus (9), eye fatigue, dry eyes, light sensitivity, and headaches (20). It can be said that high risk of ocular CVS symptoms was influenced by small distances between the eyes and the screen. Conversely, larger distances between the screen and the eye decreased CVS severity.

Individual habits in adjusting screen brightness can be seen in Table 1, which also shows the relationship analysis between adjusting screen brightness with reports of ocular CVS symptoms. Furthermore, several symptoms were identified, such as poor eye coordination and increased CVS severity due to low screen brightness (9). In addition, increased light sensitivity (15), eye pain and the sensation of a foreign body in the eye can occur due to gadget screens' intense brightness (36). However, a study conducted in Salem, India in 2020 presented different results, namely that the study did not find a relationship between brightness on gadget screens and CVS (37).

Research was done in Nepal in 2018 related to the physical environment factor, namely lighting around students when operating gadgets. This can be seen in Table 3 along with an analysis of the relationship between lighting and ocular CVS symptoms mentioned in Table 1. Natural and artificial lighting sources were reported to have no significant relationship with ocular CVS symptoms (29). This statement differs from the results reported in a study in Saudi Arabia in 2020 where changes in color perception, redness, blurry eyesight, twofold vision, and foreign body sensation were said to have a significant correlation with light sources other than the ceiling light, such as window lamps, table lamps, and screen lights in dark places (15). The report in Saudi Arabia was backed up by a study on children in Turkey in 2022, which explained that factitious illumination was significantly correlated with asthenopia (36). Natural light source users in workplaces had a lower risk of developing ocular CVS symptoms compared to those who used fluorescent lights (33). In accordance with the Visual Ergonomics Handbook from 2005, the recommended lighting when operating gadgets is 300–500 lux. It is also recommended not to place the screen directly facing the window to avoid light reflections, and use additional or artificial lighting if needed. This is because good lighting is achieved when all visual objects in the field of view have almost the same brightness or are all similar in luminance. On the other hand, poor lighting occurs when objects in the field of view have a large difference in exposure. This book also stated that the ciliary muscle in the eyeball contracts to allow the lens to become rounder in order to be able to see objects nearby. There are two sets of tiny muscles in the iris that react to lighting conditions and can become tense from working under poor lighting conditions. Extended ciliary muscle tension can cause eye fatigue (13). Another book by the International Labour Organization (ILO) in 2010 explained that operating gadgets in dark rooms causes asthenopia as the operators have to recalibrate each time they look away from the bright work spot (38).

Based on the results previously described in this study, it is clear that the most influential CVS causes are duration of gadget use, followed by the distance between eyes and gadget screen. In addition, some individual habits can also be grouped into measures to prevent ocular CVS symptoms or minimize their severity. The habits in question are anti-glare and anti-radiation filter usage, adjusting screen brightness to match the surrounding environment's lighting, and applying the 20-20-20 rule for rest.

The limitation of this study is that it did not specifically mention nor explain radiation waves emitted by gadgets and their dangers.

CONCLUSION

Ocular CVS symptoms in students were influenced by several factors such as age, gender, use of contact lenses or glasses as visual aids to correct refractive errors, type of gadget, duration of gadget use per day, frequency of gadget use per week, length of gadget use (years), blinking frequency, posture or body position when operating the gadget, pause/rest time, use of anti-glare filters, the distance between the eyes and the gadget screen, screen brightness, and lighting around the gadget user. It is recommended for gadget users to apply the 20-20-20 rule for pause/rest time, use an anti-glare or radiation filter on the gadget screen or eyeglass lenses, and adjust the screen brightness to the lighting around the gadget user. As for further research, it is recommended to observe and analyze the risk factors that cause ocular and extraocular CVS symptoms with more objective research methods and instruments.

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