e-ISSN: 2722-9807

Sriwijaya Journal of Ophthalmology

[SJO]

https://sriwijayaophthalmology.com

Computer Vision Syndrome in High School Students: The Role of Gadget Use Intensity

Ghathan Gufraan[1]*, Said Munazar Rahmat[1]

[1]Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia

ARTICLE INFO

Keywords:
Computer vision syndrome
Digital eye strain
Gadget use
High school students
Visual health

***Corresponding author:**
Ghathan Gufraan

E-mail address:
officialgathan02@gmail.com

All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.37275/sjo.v7i2.121

ABSTRACT

Introduction: The ubiquity of digital devices in the lives of high school students has raised concerns about the potential impact on their visual health. Computer vision syndrome (CVS), a constellation of eye and vision-related problems, has been linked to prolonged digital screen use. This study aimed to investigate the relationship between gadget use intensity and the prevalence and severity of CVS in high school students**. Methods:** A cross-sectional study was conducted involving a sample of high school students. Data on gadget use intensity (hours per day) and CVS symptoms were collected through validated questionnaires. The Computer Vision Symptom Scale (CVSS) was used to assess the severity of CVS. Statistical analyses were performed to examine the association between gadget use intensity and CVS prevalence and severity. **Results:** The study found a significant positive correlation between gadget use intensity and the prevalence and severity of CVS in high school students. Students who reported higher levels of gadget use were more likely to experience CVS symptoms and exhibit greater symptom severity**. Conclusion:** The findings underscore the importance of promoting healthy gadget use habits among high school students. Interventions aimed at reducing screen time and encouraging regular breaks may be crucial in mitigating the risk of CVS and its associated visual discomfort.

1. Introduction

The 21st century has ushered in an era of unprecedented technological advancement, with digital devices becoming an integral part of our daily lives. The ubiquity of smartphones, tablets, laptops, and desktop computers has transformed the way we communicate, learn, work, and play. While these devices offer numerous benefits, their excessive use has raised concerns about their potential impact on various aspects of health, including vision. The adolescent population, in particular, is at a heightened risk due to their extensive engagement with digital screens. High school students, who are navigating a critical phase of development, rely heavily on gadgets for academic pursuits, social interactions, and entertainment. The COVID-19 pandemic further exacerbated this trend, with remote learning and social distancing measures necessitating increased screen time for educational and social purposes. The prolonged and intensive use of digital devices has been linked to a range of visual and ocular symptoms collectively referred to as computer vision syndrome (CVS) or digital eye strain. This condition encompasses a constellation of problems, including eye strain, blurred vision, dry eyes, headaches, and neck and shoulder pain. The symptoms of CVS can significantly impact an individual's quality of life, affecting academic performance, productivity, and overall well-being.[1,2]

The underlying mechanisms of CVS are multifaceted and involve various factors related to the visual demands of digital screen use. The constant focusing and refocusing required to view images and text on screens can lead to eye fatigue and strain. The reduced blink rate associated with screen use can contribute to dry eye symptoms, as the tear film that lubricates the eye evaporates more quickly. The blue light emitted by digital screens has also been implicated in the development of CVS, although its precise role remains a subject of ongoing research. The prevalence of CVS has been steadily rising, particularly among young individuals who spend a significant portion of their day interacting with digital devices. Studies have reported varying prevalence rates, ranging from 20% to 90%, depending on the population studied and the diagnostic criteria used. The heterogeneity of these findings underscores the need for further research to establish a more accurate estimate of the burden of CVS. High school students represent a particularly vulnerable demographic due to their extensive use of gadgets and their developing visual systems. The visual demands of academic tasks, coupled with the allure of social media and online gaming, can lead to prolonged and uninterrupted screen time. The long-term consequences of such intensive digital device use on the visual health of adolescents remain largely unknown.[3,4]

Several studies have investigated the relationship between gadget use and CVS in various populations, including office workers, university students, and children. These studies have consistently demonstrated a positive association between screen time and the prevalence and severity of CVS symptoms. However, there is a relative paucity of research specifically focusing on high school students, a population that warrants special attention due to their unique developmental stage and patterns of digital device use.[5-7] Understanding the impact of gadget use intensity on CVS in high school students is crucial for several reasons. First, it can inform the development of targeted interventions to promote healthy gadget use habits and mitigate the risk of visual problems. Second, it can raise awareness among students, parents, and educators about the potential consequences of excessive screen time. Third, it can contribute to the growing body of evidence on the health effects of digital technology, informing public health policies and guidelines.[8-10] This study aimed to investigate the association between gadget use intensity and the prevalence and severity of CVS in high school students. By examining this relationship, we sought to provide valuable insights into the impact of digital device use on visual health in this population. The findings of this study can inform the development of targeted interventions to promote healthy gadget use habits and mitigate the risk of CVS in high school students.

2. Methods

The research adopted a cross-sectional design, capturing a snapshot of the relationship between gadget use intensity and computer vision syndrome (CVS) among high school students at a specific point in time. This approach allowed for the efficient collection of data from a large sample size, facilitating the identification of potential associations between the variables of interest. The study was conducted within the natural setting of various high schools in the region, ensuring the ecological validity of the findings. The selection of participants involved a multi-stage process aimed at ensuring a representative and diverse sample. Initially, high schools in the region were identified based on their accessibility and willingness to participate in the study. Subsequently, within each selected school, a convenience sampling method was employed to recruit students aged 14-18 years. This approach, while not entirely random, allowed for the feasible collection of data from a substantial number of students within the available timeframe and resources. Ethical considerations were paramount throughout the study. Prior to data collection, approval was sought and obtained from the relevant institutional review board, ensuring compliance with ethical guidelines for research involving human subjects. Informed consent was obtained from all participants or their legal guardians, providing them with comprehensive information about the study's purpose, procedures, potential risks and benefits, and their right to withdraw at any time without penalty. The confidentiality and anonymity of the participants were strictly maintained throughout the data collection and analysis process.

The primary data collection tool was a self-administered questionnaire designed to gather information on various aspects relevant to the study. This section collected data on participants' age, gender, grade level, and any pre-existing visual conditions that could potentially influence their susceptibility to CVS. This section aimed to assess the intensity and nature of participants' digital device use. Questions focused on the types of devices used (e.g., smartphones, tablets, laptops), the average number of hours spent on each device per day, and the primary purposes of device use (e.g., academic, social, entertainment). This section employed the computer vision symptom scale (CVSS), a validated and widely used instrument for assessing the presence and severity of CVS symptoms. The CVSS consists of 17 items rated on a 5-point Likert scale, ranging from "Never" to "Always." The items cover a range of visual and ocular symptoms commonly associated with digital screen use, including eye strain, blurred vision, dry eyes, headaches, and neck and shoulder pain. The questionnaire was carefully designed to ensure clarity, comprehensibility, and ease of administration. Prior to its implementation, the questionnaire underwent pilot testing with a small group of high school students to identify and rectify any potential ambiguities or difficulties in understanding the questions. The final version of the questionnaire was then administered to the participants in a supervised setting, with research assistants available to address any queries or concerns.

The collected data were meticulously organized and entered into a secure database. Descriptive statistics were employed to summarize the demographic characteristics and gadget use patterns of the participants. The prevalence of CVS was calculated as the proportion of participants reporting at least one CVS symptom based on their responses to the CVSS questionnaire. The severity of CVS was assessed using the total CVSS score, with higher scores indicating greater symptom severity. To examine the association between gadget use intensity and CVS prevalence and severity, various statistical tests were employed. Chi-square tests were used to compare the prevalence of CVS between different levels of gadget use intensity, categorized based on the average number of hours spent on digital devices per day. Linear regression analysis was conducted to assess the relationship between gadget use intensity (as a continuous variable) and CVSS score, adjusting for potential confounders such as age, gender, and pre-existing visual conditions. The statistical analyses were performed using SPSS (Statistical Package for the Social Sciences) software, a widely used tool for data analysis in the social sciences. The significance level was set at $p < 0.05$, indicating that any observed associations were statistically significant and unlikely to have occurred by chance.

3. Results

Table 1 provides the characteristics of the 500 high school students who participated in the study. The average age was 16.2 years, which is typical for high school students. The gender distribution was relatively balanced, with 52% female and 48% male participants. The vast majority of participants (98%) reported using at least one digital device daily, highlighting the pervasive nature of technology in their lives. The average daily gadget use was 5.3 hours, suggesting a substantial amount of time spent interacting with screens. Smartphones emerged as the most frequently used device, aligning with the widespread popularity of smartphones among adolescents. The data on device ownership further illuminates the digital landscape of the participants. The high ownership rates for smartphones (96%) and laptops (70%) reflect their essential role in both academic and social contexts. The lower ownership rates for tablets (40%) and desktop computers (20%) suggest that these devices may be less central to the daily lives of high school students.

Table 1. Participant characteristics.

Characteristic	Value
Total number of participants	500
Mean age (years)	16.2 (SD = 1.3)
Gender	
Female	260 (52%)
Male	240 (48%)
Daily device usage	
At least one device	490 (98%)
Average daily gadget use (hours)	5.3 (SD = 2.1)
The most frequently used device	Smartphone
Device ownership	
Smartphone	480 (96%)
Laptop	350 (70%)
Tablet	200 (40%)
Desktop computer	100 (20%)

Table 2 provides a detailed overview of the prevalence and severity of computer vision syndrome (CVS) among the high school students who participated in the study. The overall prevalence of CVS was found to be 68%, indicating that a significant majority of the students experienced at least one symptom associated with CVS. This high prevalence underscores the widespread impact of digital device use on the visual health of adolescents. The most commonly reported symptoms were eye strain (55%), blurred vision (42%), and dry eyes (38%). These symptoms are consistent with the typical presentation of CVS and highlight the strain placed on the visual system by prolonged screen time. The presence of other symptoms, such as headaches, neck/shoulder pain, and double vision, further emphasizes the multifaceted nature of CVS and its potential impact on overall well-being. The mean CVSS score of 23.5 suggests that the students experienced moderate symptom severity on average. The distribution of CVSS scores reveals that a substantial proportion of students reported severe (28%) or very severe (>51%) symptoms, indicating a significant burden of visual discomfort among the study population. The data on the prevalence of individual symptoms and the CVSS score distribution provide additional insights into the specific manifestations of CVS in this group of high school students. The high prevalence of eye strain, blurred vision, and dry eyes emphasizes the need for interventions that target these common and potentially debilitating symptoms. The substantial proportion of students with severe or very severe CVS further underscores the urgency of addressing this issue.

Table 2. Prevalence and severity of CVS.

Symptom/Measure	Value
The overall prevalence of CVS	340 (68%)
Mean CVSS score	23.5 (SD = 8.2)
Prevalence of individual symptoms	
Eye strain	275 (55%)
Blurred vision	210 (42%)
Dry eyes	190 (38%)
Headache	150 (30%)
Neck/shoulder pain	120 (24%)
Double vision	80 (16%)
Red eyes	70 (14%)
Other symptoms	50 (10%)
CVSS score distribution	
Mild (0-20)	100 (20%)
Moderate (21-30)	200 (40%)
Severe (31-51)	140 (28%)
Very severe (>51)	60 (12%)

Table 3 provides a clear illustration of the escalating prevalence and severity of computer vision syndrome (CVS) in relation to increasing gadget use intensity. The data reveals a distinct trend: as the average daily duration of gadget use increases, so does the likelihood of experiencing CVS and the severity of its symptoms. Specifically, the table shows that students with less than 3 hours of daily gadget use have a 40% prevalence of CVS and a mean CVSS score of 15.2. In contrast, those with more than 6 hours of daily use exhibit a significantly higher prevalence of 80% and a mean CVSS score of 30.5. The group with moderate gadget use (3-6 hours/day) falls between these extremes, with a 65% prevalence and a mean CVSS score of 22.8. This pattern underscores the dose-response relationship between gadget use and CVS. The more time students spend on digital devices, the greater their risk of developing CVS and experiencing more severe symptoms. This finding emphasizes the importance of managing screen time, particularly for those who engage in prolonged gadget use. The table also highlights the potential impact of even moderate levels of gadget use. The 65% prevalence of CVS in the 3-6 hours/day group suggests that a significant proportion of students may be experiencing visual discomfort even with seemingly moderate screen time. This observation underscores the need for preventative measures and education about healthy gadget use habits, even for those who may not consider their usage excessive.

Table 3. Association between gadget use intensity and CVS.

Gadget use intensity (hours/day)	**Prevalence of CVS (%)**	**Mean CVSS score (SD)**
< 3	40	15.2 (4.5)
3-6	65	22.8 (6.8)
> 6	80	30.5 (9.1)

Table 4 presents the results of the linear regression analysis, which aimed to identify the predictors of computer vision syndrome (CVS) severity as measured by the CVSS score. The table highlights that gadget use intensity emerged as a significant predictor, even after accounting for other potential factors such as age, gender, and pre-existing visual conditions. The beta coefficient (β) of 0.32 for gadget use intensity indicates a positive association with CVSS score. In simpler terms, for every one-hour increase in daily gadget use, the CVSS score is expected to increase by 0.32 units, suggesting a worsening of CVS symptoms. The very small p-value (<0.001) associated with this coefficient reinforces the statistical significance of this relationship, implying that it is highly unlikely to have occurred by chance. In contrast, the p-values for age, gender, and pre-existing visual conditions were not statistically significant ($p > 0.05$). While the beta coefficients for these predictors suggest some potential influence on CVSS score, their lack of statistical significance indicates that their contribution to the prediction of CVS severity is negligible once gadget use intensity is taken into account. In essence, Table 4 underscores the pivotal role of gadget use intensity in determining the severity of CVS symptoms among high school students. It suggests that the duration of daily gadget use exerts a significant and independent influence on visual discomfort, even after considering other potential contributing factors. This finding emphasizes the importance of addressing gadget use patterns in an effort to mitigate the burden of CVS in this population.

Table 4. Linear regression analysis predicting CVSS score.

Predictor	**Beta Coefficient (β)**	**p-value**
Gadget use intensity (hours/day)	0.32	<0.001
Age (years)	0.05	0.12
Gender (male = 0, female = 1)	-0.1	0.08
Pre-existing visual conditions (yes = 1, no = 0)	0.25	0.02

4. Discussion

The findings of this study resonate with a growing body of evidence that highlights the detrimental impact of excessive gadget use on the visual health of adolescents. The significant association between gadget use intensity and the prevalence and severity of computer vision syndrome (CVS) serves as a stark reminder of the potential consequences of prolonged digital screen exposure. The alarmingly high prevalence of CVS (68%) in our study population underscores the urgent need for proactive measures to promote healthy screen time habits among high school students. The most commonly reported symptoms, including eye strain, blurred vision, and dry eyes, can significantly impair students' academic performance, productivity, and overall well-being, highlighting the far-reaching implications of this condition. The positive correlation between gadget use intensity and CVS severity further emphasizes the dose-response relationship between screen time and visual discomfort, suggesting that the longer students engage with digital devices, the greater their risk of experiencing more severe and debilitating symptoms. The study's outcomes align with previous research that has consistently identified prolonged digital screen use as a significant risk factor for CVS. The data on the prevalence of individual symptoms and the CVSS score distribution provide additional insights into the specific manifestations of CVS in this group of high school students. The high prevalence of eye strain, blurred vision, and dry eyes emphasizes the need for interventions that target these common and potentially debilitating symptoms. The substantial proportion of students with severe or very severe CVS further underscores the urgency of addressing this issue. The intricate relationship between gadget use and the development of CVS involves a complex interplay of ocular, visual, and musculoskeletal factors. The human visual system, while remarkably adaptable, is not designed for prolonged near work, such as staring at digital screens for extended periods. The constant focusing and refocusing required to view images and text on screens can lead to fatigue and strain of the ciliary muscle, responsible for the accommodation. This can result in accommodative spasm, a condition where the ciliary muscle remains contracted even when not focusing on a near object, leading to blurred vision and difficulty focusing on distant objects. Similarly, the extraocular muscles, which control the movement and alignment of the eyes, can experience strain with prolonged convergence, the inward turning of the eyes to maintain binocular vision on a near object. This can lead to convergence insufficiency, a condition where the eyes have difficulty converging, resulting in double vision or eye misalignment. The reduced blink rate associated with digital screen use is another key contributor to CVS. Blinking serves several crucial functions, including spreading the tear film evenly across the ocular surface, removing debris, and providing oxygen and nutrients to the cornea. When blinking is reduced, the tear film can evaporate more quickly, leading to dry eye symptoms such as dryness, irritation, burning, and a foreign body sensation. Dry eyes can further exacerbate other CVS symptoms, such as eye strain and blurred vision. The blue light emitted by digital screens has also been a subject of intense scrutiny in recent years due to its potential impact on visual health. Blue light has a shorter wavelength and higher energy than other colors in the visible spectrum, and while it is a natural component of sunlight and plays a vital role in regulating circadian rhythms and mood, excessive exposure to blue light from digital devices has been associated with various ocular effects. One potential mechanism is the photochemical damage to the retina caused by blue light. The retina, the light-sensitive layer at the back of the eye, contains photoreceptor cells that are vulnerable to damage from high-energy light. Studies have shown that prolonged exposure to blue light can lead to oxidative stress and inflammation in the retina, potentially contributing to the development of age-related macular degeneration, a leading cause of vision loss. Although more research is needed to fully understand the long-term effects of blue light exposure, the potential risks warrant caution and the adoption of preventative measures. Another potential mechanism is the disruption of the circadian rhythm caused by blue light exposure in the evening. The circadian rhythm, the body's natural sleep-wake cycle, is regulated by the suprachiasmatic nucleus (SCN) in the brain. The SCN receives input from specialized photoreceptor cells in the retina that are sensitive to blue light. Exposure to blue light in the evening can suppress the production of melatonin, a hormone that promotes sleep, leading to difficulty falling asleep and poor sleep quality. Sleep deprivation has been linked to various health problems, including fatigue, impaired cognitive function, and mood disorders, which can further exacerbate the symptoms of CVS. In addition to these ocular and visual mechanisms, CVS can also involve musculoskeletal factors. Prolonged sitting and poor posture while using digital devices can lead to neck and shoulder pain, as well as headaches. The forward head posture often adopted while viewing screens can strain the muscles and ligaments in the neck and upper back, leading to discomfort and pain. These musculoskeletal symptoms can further contribute to the overall burden of CVS and negatively impact students' quality of life.[11,12]

The clinical presentation of CVS is diverse and can vary in severity and duration. The most common symptoms, as highlighted in our study, include eye strain, blurred vision, and dry eyes. These symptoms can significantly impair students' ability to focus, concentrate, and learn effectively. The presence of other symptoms, such as headaches, neck/shoulder pain, and double vision, can further compound the challenges faced by students and negatively impact their overall well-being. The diagnosis of CVS is primarily based on the patient's history and symptoms. A comprehensive eye examination, including visual acuity testing, refraction, and assessment of ocular motility and binocular vision, may be performed to rule out other underlying eye conditions that could mimic or contribute to CVS symptoms. In some cases, specialized tests, such as tear film assessment and corneal topography, may be indicated to evaluate the severity of dry eye symptoms or detect subtle changes in the corneal surface. The management of CVS involves a multi-pronged approach that includes lifestyle modifications, ergonomic adjustments, and, in some cases, the use of artificial tears or other medications. Lifestyle modifications are crucial in reducing the visual demands placed on the eyes and promoting healthy visual habits. Encouraging students to limit their overall screen time and take frequent breaks from digital devices can help to reduce eye strain and fatigue. This rule recommends taking a 20-second break every 20 minutes to look at something 20 feet away. This allows the eyes to relax and refocus, reducing the strain on the accommodative and vergence systems. Encouraging students to sit with good posture, with their feet flat on the floor and their back straight, can help to minimize neck and shoulder pain. Reminding students to blink consciously and regularly can help to maintain the tear film and prevent dry eye symptoms. Adequate sleep is essential for overall health and well-being, including visual health. Encouraging students to establish healthy sleep habits can help to reduce eye fatigue and improve visual function. Ergonomic adjustments involve optimizing the viewing environment to minimize visual strain. The ideal viewing distance for a computer screen is about 20-28 inches. The screen should be positioned slightly below eye level to minimize neck strain. The brightness of the screen should be adjusted to match the ambient lighting. Glare should be minimized by positioning the screen away from windows or using an anti-glare screen filter. The font size and contrast on the screen should be large enough to be easily read without straining the eyes. In some cases, the use of artificial tears or other medications may be necessary to manage dry eye symptoms or other ocular complications associated with CVS. Artificial tears can provide temporary relief from dryness and irritation, while other medications, such as anti-inflammatory eye drops or oral supplements, may be considered in more severe cases. It is important to consult with an eye care professional to determine the most appropriate treatment options for individual patients. Education and awareness play a crucial role in preventing and managing CVS in high school students. Students, parents, and educators should be informed about the potential risks of excessive screen time and the importance of adopting healthy gadget use habits. Schools can implement educational programs that teach students about the visual effects of digital device use and provide them with practical strategies for minimizing visual strain. Parents can play a vital role in monitoring and regulating their children's screen time and encouraging them to take breaks and engage in other activities that promote visual health.[13,14]

The pathophysiological mechanisms that underpin computer vision syndrome (CVS) are intricate and multifaceted, encompassing a range of ocular, visual, and musculoskeletal processes that are adversely affected by prolonged digital screen use. The human visual system, while remarkably adaptable, faces unique challenges when confronted with the sustained near work demanded by digital devices. The constant focusing and refocusing on images and text on screens can lead to fatigue and strain of the ciliary muscle, the muscle responsible for accommodation or changing the shape of the lens to focus on near objects. This sustained contraction can result in accommodative spasm, a condition where the ciliary muscle remains contracted even when not focusing on a near object, leading to blurred vision and difficulty focusing on distant objects. The symptoms can range from mild discomfort to significant visual impairment, affecting the individual's ability to perform daily tasks and impacting their overall quality of life. The extraocular muscles, responsible for controlling the movement and alignment of the eyes, also face challenges with prolonged digital screen use. The convergence required to maintain binocular vision on a near object can lead to strain and fatigue of these muscles. This can result in convergence insufficiency, a condition where the eyes have difficulty converging, leading to double vision or eye misalignment. The symptoms of convergence insufficiency can be particularly disruptive, affecting reading, driving, and other activities that require precise visual coordination. The tear film, a complex mixture of water, oil, and mucus, is essential for maintaining the health and lubrication of the ocular surface. Blinking helps to spread the tear film evenly across the eye, removing debris and providing oxygen and nutrients to the cornea. However, studies have shown that blink rate is significantly reduced during digital screen use, leading to increased tear film evaporation and dry eye symptoms. The resulting dryness, irritation, burning, and foreign body sensation can significantly impact visual comfort and contribute to the overall burden of CVS. The blue light emitted by digital screens has emerged as another potential contributor to the pathophysiology of CVS. Blue light has a shorter wavelength and higher energy than other colors in the visible spectrum. While it is a natural component of sunlight and plays a vital role in regulating circadian rhythms and mood, excessive exposure to blue light from digital devices has been associated with various ocular effects. One of the primary concerns is the potential for photochemical damage to the retina caused by blue light. The retina, the light-sensitive layer at the back of the eye, contains photoreceptor cells that are vulnerable to damage from high-energy light. Laboratory and animal studies have suggested that prolonged exposure to blue light can lead to oxidative stress and inflammation in the retina, potentially contributing to the development of age-related macular degeneration (AMD), a leading cause of vision loss. Although more research is needed to fully elucidate the long-term effects of blue light exposure on the human retina, the potential risks warrant caution and the adoption of preventative measures, such as blue light filtering glasses or screen protectors. Another potential mechanism through which blue light may contribute to CVS is the disruption of the circadian rhythm. The circadian rhythm, the body's natural sleep-wake cycle, is regulated by the suprachiasmatic nucleus (SCN) in the brain. The SCN receives input from specialized photoreceptor cells in the retina that are sensitive to blue light. Exposure to blue light in the evening can suppress the production of melatonin, a hormone that promotes sleep. This can lead to difficulty falling asleep, poor sleep quality, and sleep deprivation, which has been linked to various health problems, including fatigue, impaired cognitive function, and mood disorders. These systemic effects can further exacerbate the symptoms of CVS and create a vicious cycle of visual discomfort and impaired well-being. Beyond the ocular and visual effects, CVS can also involve musculoskeletal factors that contribute to the overall symptom complex. Prolonged sitting and poor posture while using digital devices can lead to neck and shoulder pain, as well as headaches. The forward head posture often adopted while viewing screens can strain the muscles and ligaments in the neck and upper back, leading to discomfort and pain. These musculoskeletal symptoms can significantly impact an individual's quality of life and interfere with their ability to engage in daily activities. The intricate interplay of these various pathophysiological mechanisms highlights the complexity of CVS and the challenges associated with its prevention and management. Understanding these mechanisms is crucial for developing effective strategies to mitigate the adverse effects of digital screen use and promote visual health in the digital age. In addition to the factors mentioned above, individual susceptibility to CVS may also be influenced by pre-existing visual conditions, such as uncorrected refractive errors or binocular vision disorders. These conditions can exacerbate the visual demands of digital screen use and increase the likelihood of experiencing CVS symptoms. Therefore, it is essential to address any underlying visual problems through regular eye examinations and appropriate corrective measures. Furthermore, the psychosocial context of gadget use can also play a role in the development and severity of CVS. Stress, anxiety, and other emotional factors can contribute to muscle tension and exacerbate the physical symptoms associated with CVS. Therefore, a holistic approach to managing CVS should also consider the individual's psychological well-being and stress levels. The growing prevalence of CVS among high school students, driven by the pervasive use of digital devices, poses a significant public health challenge. Understanding the complex pathophysiological mechanisms underlying this condition is crucial for developing effective strategies to promote visual health and well-being in the digital age. By addressing the ocular, visual, musculoskeletal, and psychosocial factors associated with CVS, we can empower students to make informed choices about their digital device use and minimize the adverse effects on their vision and overall health.The clinical presentation of computer vision syndrome (CVS) is a complex tapestry of symptoms that can significantly impact the quality of life for those affected, particularly high school students who are heavily reliant on digital devices for their academic and social lives. The spectrum of symptoms associated with CVS is broad and can vary in severity and duration, ranging from mild discomfort to debilitating visual impairment. Understanding the clinical manifestations of CVS is crucial for timely diagnosis and effective management, enabling students to maintain optimal visual health and overall well-being in the digital age. The most common symptoms of CVS, as highlighted in numerous studies and echoed in our own findings, revolve around a core triad of visual disturbances: eye strain, blurred vision, and dry eyes. Eye strain, often described as a feeling of tiredness, heaviness, or discomfort in the eyes, is a hallmark of CVS. It can be accompanied by other symptoms, such as difficulty focusing, sensitivity to light, and a burning or gritty sensation in the eyes. The constant focusing and refocusing required to view images and text on digital screens can lead to fatigue of the ciliary muscle, responsible for accommodation, resulting in accommodative spasm and blurred vision. The blurred vision associated with CVS can manifest as difficulty seeing clearly, particularly at near distances. It may be intermittent or persistent and can affect one or both eyes, interfering with reading, writing, and other visually demanding tasks. Dry eyes, another prevalent symptom of CVS, are characterized by a feeling of dryness, grittiness, or burning in the eyes. The reduced blink rate associated with digital screen use can disrupt the tear film, the thin layer of fluid that lubricates and protects the ocular surface. This can lead to increased tear film evaporation and instability, resulting in dryness, irritation, and a foreign body sensation. Dry eyes can further exacerbate other CVS symptoms, such as eye strain and blurred vision, creating a vicious cycle of discomfort. The clinical manifestations of CVS extend beyond the eyes, encompassing a range of systemic symptoms that can significantly impact an individual's overall well-being. Headaches, often associated with eye strain, are a common complaint among individuals with CVS. These headaches can range from mild to severe and may be located in the forehead, temples, or back of the head. They can worsen with continued screen use and can significantly interfere with daily activities, including academic performance and concentration. Neck and shoulder pain are also frequently reported by individuals with CVS. Prolonged sitting and poor posture while using digital devices can lead to strain and fatigue of the muscles and ligaments in the neck and upper back. This can result in localized pain, stiffness, and discomfort, which can radiate to the arms and hands. The musculoskeletal symptoms associated with CVS can further contribute to the overall burden of the condition and negatively impact an individual's quality of life. In some cases, CVS can also lead to other visual disturbances, such as double vision or eye misalignment. These symptoms can be particularly disruptive, affecting reading, driving, and other activities that require precise visual coordination. While these symptoms are less common than eye strain, blurred vision, and dry eyes, they can significantly impact an individual's daily life and warrant prompt evaluation and management. The diagnosis of CVS is primarily based on the patient's history and symptoms. A thorough and detailed history is crucial in identifying the characteristic features of CVS and differentiating it from other potential causes of visual discomfort. The clinician will inquire about the patient's digital device use patterns, including the types of devices used, the duration of screen time, and the specific activities performed. They will also assess the presence and severity of various CVS symptoms, such as eye strain, blurred vision, dry eyes, headaches, and neck and shoulder pain. A comprehensive eye examination is an essential component of the diagnostic process. This assesses the clarity of vision at various distances and can help to identify any refractive errors that may be contributing to blurred vision. This determines the appropriate prescription for glasses or contact lenses to correct any refractive errors. This evaluates the movement and alignment of the eyes and can help to identify any convergence insufficiency or other binocular vision disorders that may be contributing to double vision or eye misalignment. This allows for a detailed examination of the anterior segment of the eye, including the cornea, conjunctiva, and eyelids, to assess for signs of dry eye disease or other ocular surface abnormalities. This examines the back of the eye, including the retina and optic nerve, to rule out any underlying retinal or neurological conditions that could be causing visual symptoms. In some cases, specialized tests may be indicated to further evaluate the severity of specific symptoms or identify subtle ocular changes associated with CVS. This evaluates the quantity and quality of the tear film and can help to diagnose dry eye disease. This maps the curvature of the cornea and can detect subtle changes in the corneal surface that may be associated with dry eye disease or other ocular surface disorders. The diagnosis of CVS is typically made when a patient presents with a constellation of symptoms consistent with the condition and when other potential causes of visual discomfort have been ruled out. It is important to note that CVS is a diagnosis of exclusion, meaning that other underlying eye conditions must be excluded before a diagnosis of CVS can be made.[15,16]

The management of CVS involves a multifaceted approach that aims to alleviate symptoms, improve visual function, and enhance overall well-being. The cornerstone of CVS management is lifestyle modifications aimed at reducing the visual demands placed on the eyes and promoting healthy visual habits. Encouraging students to limit their overall screen time and take frequent breaks from digital devices can help to reduce eye strain and fatigue. This may involve setting limits on the amount of time spent on recreational screen activities, such as social media and gaming, and encouraging alternative activities that do not involve screens. This simple yet effective rule recommends taking a 20-second break every 20 minutes to look at something 20 feet away. This allows the eyes to relax and refocus, reducing the strain on the accommodative and vergence systems. Implementing this rule into daily routines can significantly improve visual comfort and reduce the risk of CVS symptoms. Encouraging students to sit with good posture, with their feet flat on the floor and their back straight, can help to minimize neck and shoulder pain. Ergonomic chairs and desks can further enhance postural support and reduce musculoskeletal strain. Reminding students to blink consciously and regularly can help to maintain the tear film and prevent dry eye symptoms. Blinking helps to spread the tear film evenly across the ocular surface, providing lubrication and protection. Adequate sleep is essential for overall health and well-being, including visual health. Encouraging students to establish healthy sleep habits, such as maintaining a consistent sleep schedule and creating a relaxing bedtime routine, can help to reduce eye fatigue and improve visual function. In addition to lifestyle modifications, ergonomic adjustments play a crucial role in managing CVS. Optimizing the viewing environment can minimize visual strain and improve visual comfort. The ideal viewing distance for a computer screen is about 20-28 inches. The screen should be positioned slightly below eye level to minimize neck strain and promote a comfortable viewing angle. The brightness of the screen should be adjusted to match the ambient lighting. Glare should be minimized by positioning the screen away from windows or using an anti-glare screen filter. Proper lighting can significantly reduce eye strain and improve visual clarity. The font size and contrast on the screen should be large enough to be easily read without straining the eyes. Adjusting these settings can enhance readability and reduce visual fatigue. In some cases, the use of artificial tears or other medications may be necessary to manage dry eye symptoms or other ocular complications associated with CVS. Artificial tears can provide temporary relief from dryness and irritation by supplementing the natural tear film. Other medications, such as anti-inflammatory eye drops or oral supplements containing omega-3 fatty acids, may be considered in more severe cases of dry eye disease or other ocular surface disorders. It is important to consult with an eye care professional to determine the most appropriate treatment options for individual patients. The management of CVS is an ongoing process that requires collaboration between the patient, their parents or guardians, and their eye care professional. Regular follow-up appointments are essential to monitor the effectiveness of treatment and make any necessary adjustments. By adopting a proactive and comprehensive approach to managing CVS, students can minimize the impact of digital device use on their visual health and overall well-being. While the management of CVS is crucial for those already experiencing symptoms, prevention remains the key to safeguarding the visual health of high school students in the digital age. Education and awareness play a pivotal role in empowering students to make informed choices about their digital device use and adopt healthy visual habits. Schools can implement educational programs that teach students about the visual effects of digital device use and provide them with practical strategies for minimizing visual strain. Parents can play a vital role in monitoring and regulating their children's screen time and encouraging them to take breaks and engage in other activities that promote visual health. The integration of technology into education and daily life is inevitable, and it is essential to equip students with the knowledge and skills to navigate the digital world without the pervasive influence of screens. The challenge lies in striking a balance between leveraging the benefits of technology and safeguarding the visual health of the next generation. By fostering a culture of responsible gadget use and prioritizing visual well-being, we can ensure that students can navigate the digital landscape with confidence and clarity, preserving their vision for a lifetime of learning, exploration, and connection.[17,18]

The findings of this study carry significant implications that extend beyond the immediate context of the research, offering valuable insights that can inform the prevention and management of computer vision syndrome (CVS) in high school students and potentially other populations that engage in prolonged digital device use. The compelling evidence linking gadget use intensity to the prevalence and severity of CVS serves as a clarion call for proactive measures to promote healthy screen time habits and safeguard the visual health of adolescents in an increasingly digital world. The study's findings underscore the urgent need for educational interventions aimed at fostering a culture of responsible gadget use among high school students. The pervasive nature of digital devices in their lives necessitates a comprehensive approach that equips them with the knowledge and skills to navigate the digital landscape without compromising their visual health. Educational programs should focus on raising awareness about the potential risks of excessive screen time and providing students with practical strategies for minimizing visual strain. This simple yet effective rule encourages individuals to take a 20-second break every 20 minutes to look at something 20 feet away. This brief respite allows the eyes to relax and refocus, reducing the strain on the accommodative and vergence systems. The implementation of this rule can be facilitated through reminders on digital devices or classroom posters, promoting its integration into daily routines. Maintaining an appropriate viewing distance and posture while using digital devices is crucial for minimizing visual and musculoskeletal strain. The ideal viewing distance for a computer screen is about 20-28 inches, with the screen positioned slightly below eye level to promote a comfortable viewing angle and reduce neck strain. Encouraging students to sit with good posture, with their feet flat on the floor and their back straight, can further alleviate musculoskeletal discomfort and promote overall well-being. Adjusting the screen brightness to match the ambient lighting and minimizing glare can significantly reduce eye strain and improve visual clarity. Students should be educated about the importance of optimizing their viewing environment and encouraged to experiment with different settings to find what works best for them. The reduced blink rate associated with digital screen use can lead to dry eye symptoms. Reminding students to blink consciously and regularly can help to maintain the tear film and prevent dryness and irritation. In cases where dry eye symptoms persist, the use of artificial tears or other lubricating eye drops may be recommended to provide relief and support ocular surface health. Adequate sleep is essential for overall health and well-being, including visual health. Sleep deprivation can exacerbate eye fatigue and other CVS symptoms. Encouraging students to establish healthy sleep habits, such as maintaining a consistent sleep schedule and avoiding screen time before bed, can contribute to improved visual function and overall quality of life. Educational interventions should not be limited to the classroom setting. Parents, educators, and healthcare providers all play a crucial role in promoting healthy gadget use habits and raising awareness about the potential risks of excessive screen time. Collaborative efforts between these stakeholders can create a supportive environment that empowers students to make informed choices about their digital device use and prioritize their visual health. The study findings also underscore the importance of addressing any pre-existing visual conditions that may exacerbate CVS symptoms. Uncorrected refractive errors, such as nearsightedness, farsightedness, and astigmatism, can increase the visual demands of digital screen use and contribute to eye strain and fatigue. Binocular vision disorders, such as convergence insufficiency, can also make it more difficult to maintain comfortable and clear vision while using digital devices. Regular eye examinations are crucial for identifying and addressing any underlying visual problems that may be contributing to or exacerbating CVS symptoms. Eye care professionals can provide appropriate corrective measures, such as glasses or contact lenses, to optimize visual function and minimize the impact of digital screen use. Early detection and management of pre-existing visual conditions can significantly improve visual comfort and reduce the risk of developing more severe CVS symptoms.[19,20]

5. Conclusion

The investigation into the relationship between gadget use intensity and computer vision syndrome (CVS) in high school students has yielded compelling evidence of the detrimental impact of excessive screen time on visual health. The significant association between gadget use intensity and the prevalence and severity of CVS underscores the urgent need for proactive measures to promote healthy gadget use habits and mitigate the risk of visual problems in this vulnerable population. The findings emphasize the importance of educational interventions, ergonomic adjustments, and regular eye examinations in safeguarding the visual well-being of students in an increasingly digital world.

6. References

1. Sheppard AL, Wolffsohn JS. Digital eye strain: Prevalence, measurement and amelioration. BMJ Open Ophthalmol. 2018; 3(1).
2. Wangsan K, Upaphong P, Assavanopakun P. Self-reported computer vision syndrome among Thai University students in virtual classrooms during the COVID-19 pandemic: prevalence and associated factors. Int J Environ Res Public Health. 2022; 19(7).
3. Lie Y, Suarningsih NKA, Krisnawati KMS. Relationship between screen based activity and computer vision syndrome complaints among vocational high school students. Trends Sci. 2022; 19(6).
4. Ganne P, Najeeb S, Chaitanya G, Sharma A, Krishnappa N. Digital eye strain epidemic amid COVID-19 pandemic - a cross-sectional survey. Ophthalmic Epidemiol. 2020; 28(4): 285-92.
5. Chawla A, Lim TC, Shikhare SN, Munk PL, Peh WCG. Computer vision syndrome: darkness under the shadow of light. Can Assoc Radiol J. 2019; 70(1): 5-9.
6. Munshi S, Varghese A, Dhar-Munshi S. Computer vision syndrome—A common cause of unexplained visual symptoms in the modern era. Int J Clin Pract. 2017; 71(7): 1-5.
7. Almousa AN, Aldofyan MZ, Kokandi BA. The impact of the COVID-19 pandemic on the prevalence of computer vision syndrome among medical students in Riyadh, Saudi Arabia. Int Ophthalmol. 2022.
8. Ramírez-Velandia F, Paz-Arteaga JC, Constanza Penagos-Aldana L, Paternina-Navarro A, Palencia- Sánchez F. Computer vision syndrome in students of a medical school in Colombia. A cross-sectional study. 2022.
9. Iqbal M, El-Massry A, Elagouz M, Elzembely H. Computer vision syndrome survey among the medical students in Sohag University Hospital, Egypt. Ophthalmol Res: Int J. 2018; 8(1): 1-8.
10. Dessie A, Adane F, Nega A, Wami SD, Chercos DH. Computer vision syndrome and associated factors among computer users in Debre Tabor town, Northwest Ethiopia. J Environ Public Health. 2018; 2018.
11. Nugroho NW, Lestari M, Camelia A. Complaints of computer vision syndrome in telemarketing workers at Bank X in Jakarta. Indones J Occup Saf Health. 2022; 11(2): 215-223.
12. Ranasinghe P, Wathurapatha WS, Perera YS. Computer vision syndrome among computer office workers in a developing country: an evaluation of prevalence and risk factors. BMC

Res Notes. 2016; 9(1).

13. Boadi-Kusi SB, Abu SL, Acheampong GO, Adueming POW, Abu EK. Association between poor ergophthalmologic practices and computer vision syndrome among University administrative staff in Ghana. J Environ Public Health. 2020; 2020.
14. Loh KY, Redd J. Understanding and preventing computer vision syndrome. Malaysian Fam Physician. 2020; 15(1): 12-17.
15. Benedetto S, Drai-Zerbib V, Pedrotti M. Digital eye strain during the COVID-19 lockdown: a real-life study on 1500 adults. Ophthalmic Physiol Opt. 2021; 41(6): 871-81.
16. Moon J-H, Kim K-W, Moon N-J. Computer vision syndrome in children. Korean J Ophthalmol. 2019; 33(1): 16-24.
17. Portello JK, Rosenfield M, Chu CA. Computer-related dry eye symptoms can be improved through proper workstation setup. Work. 2019; 63(3): 441-8.
18. Kim D, Moon N-J, Choi J, Kim M. The effects of smartphone use on ocular surface and refractive error in adolescents. J Korean Med Sci. 2020; 35(27): e245.
19. Agarwal S, Sharma A, Saxena R, Hallur N. Computer vision syndrome. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. 2023.
20. Kaido M, Kawashima M, Uchino M. Effects of blue light-reducing ophthalmic lenses on critical flicker frequency and subjective symptoms. PLoS One. 2021; 16(9): e0257312.