Digital Devices use and Ocular Health of Adolescents

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Abstract:

Recent advancements in technology in terms of smartphones, tablets, and computers, have profoundly altered the lifestyles of children and adolescents. Their reliance on these devices has risen in recent years. Numerous studies highlighting the adverse effects of digital device on neurological health among young users. Extended use of digital devices can lead to eye strain or computer vision syndrome, characterized by symptoms like dry eyes, discomfort, blurred vision, and headaches. This study aims to examine the effect of digital device use on ocular health of adolescents. This cross-sectional study conducted in Nagpur city that involves 548 adolescents. The adolescents were categorized based on their constant use of digital devices through a screening test and a self-administered questionnaire. Ocular health of adolescents was assessed using the Computer Vision Syndrome (CVS) Scale. Descriptive analysis showed that significant percentage (64%) of students using digital device frequently experienced symptoms of vision problems, such as eye strain and headaches. The findings suggest a notable difference in ocular health between adolescents who frequently use digital devices and those who do not. While digital devices provide many benefits, their improper or excessive use can lead to health issues, including vision problems and headaches. Educating adolescents on healthy screen habits and encouraging regular breaks from digital devices are vital strategies to alleviate these negative effects and promote overall well-being. Consequently, it is important for parents and caregivers to monitor the duration, frequency and screen habits of adolescents' digital device use.

Keywords: Digital devices, Ocular health, Digital eye strain, Vision problem, Computer vison syndrome, Eye strain, Adolescents

1. Introduction

Ocular health such as eye strain, also known as digital eye strain or computer vision syndrome, comprises a range of symptoms including dry eyes, blurred vision, headaches, and neck pain (Reddy, 2021). These symptoms are commonly reported by children and adolescents who spend extended periods using digital screens for academic and recreational purposes. The American Optometric Association (2020) identifies several ways in which digital devices contribute to eye strain. These mechanisms include prolonged periods of focusing on close distances, increased exposure to blue light from screens, and decreased blink rates, which can result in dry eyes.

Mobile phones and digital devices have become prevalent in the lives of children. These devices act as an innovative tool in variety of ways in education, in play, especially games, and in everyday communication. The integration of digital technology into children's lives increasingly affects their cognitive, emotional, and social development each day. Technology offers many opportunities for children to play, explore, and learn (Linebarger & Piotrowski, 2009). Since children’s brains are extremely flexible in this period, these learning opportunities constitute a critical developmental point in children and through the

natural exploration and discovery of their own world, new connections between neurons are formed and existing connections are strengthened (Blanchard & Moore, 2010).

Adolescents and children are increasingly reliant on digital devices for communication, education, and entertainment (Rosenfield, 2011). A study by Li et al. (2020) found that average screen time among adolescents has significantly increased over the past decade, which has implications for eye health. Concerns about the potential harms of its use are rapidly growing, especially on their neurological health of children and adolescents. The effect of digital devices on the neurological health of adolescents is becoming an increasingly important concern. Numerous studies shed light on how the use of digital devices affects eye health, including issues such as digital eye strain, dry eye symptoms, and associations with refractive errors like myopia.

Rosenfield's study in 2016 discusses the prevalence of digital eye strain among computer users, measurement techniques for evaluating symptoms, and strategies to alleviate discomfort, such as adjusting screen settings and taking breaks. J. S. Khattak et al. (2020) highlight the potential impacts of digital device use on eye fatigue and discomfort. Liu et al. review the effects of digital device use on ocular health, including digital eye strain, dry eye syndrome, and myopia progression, emphasizing the impact of prolonged screen time on visual discomfort and its potential long-term consequences for eye health.

In 2019, Huynh K et al. investigated the relationship between electronic device use and ocular surface health, exploring how it affects tear film stability and dry eye symptoms. Additionally, Algvere P. V. et al. (2018) examined the effects of blue light emitted by digital screens on circadian rhythms and eye physiology, noting potential risks to sleep patterns and retinal health.

In 2020, Xiong S. et al. conducted a systematic review and meta-analysis examining the prevalence of asthenopia (eye strain) among Chinese students, linking it to prolonged screen time and near work activities. Research by Subhi et al. (2019) suggests that excessive screen time during childhood and adolescence may affect visual development, potentially resulting in myopia (near sightedness) and other refractive errors. The authors stress the importance of taking regular breaks and engaging in outdoor activities to help mitigate these effects.

Objectives:

To study the effect of digital device, use on ocular health of adolescents.

Null Hypothesis (H_0):

There will be no significant difference in the ocular health of adolescents who use digital devices frequently and those who do not.

Alternative Hypothesis (H_1):

There will be significant difference in the ocular health of adolescents who use digital devices frequently and those who do not.

2. Methods

Participants and study design

This cross-sectional study involved 548 adolescents aged 13-19 years from five schools in Nagpur city. The participants were selected using a stratified random sampling method to ensure representation across various age groups within the specified range.

To investigate the impact of digital device usage on ocular health, specifically eye strain, a descriptive survey approach was used. The study employed a comparative design involving two groups: one consisting of adolescents who frequently use digital devices and the other of those who use them less often. The aim was to compare their experiences of eye strain and headaches.

Materials

Data were collected using a questionnaire that can be divided into the following sections:
(i) Demographic information including information on daily usage of digital devices.
(ii) CVS symptoms experienced by the participants which was adopted from CVS-Q (Segui et al, 2015).

(i) Screening test:

A self-developed survey questionnaire was employed to assess the usage of mobile and digital devices among adolescents. In addition to collecting demographic information such as grade, age, and gender, this questionnaire comprised 17 items. These items included inquiries regarding the frequency of digital device use, daily usage duration, specific types of devices utilized, purposes for which devices are used, and parental preferences regarding mobile phone and TV usage within the adolescent's daily routine. This questionnaire was designed to comprehensively capture adolescents' interactions with mobile and digital devices, providing insights into usage patterns and parental influences on device utilization during daily activities.

(ii) Computer Vision Syndrome (CVS) Scale:

The Computer Vision Syndrome (CVS) Scale is a tool developed to evaluate the presence and severity of symptoms linked to prolonged digital screen use. The CVS-Q, a comprehensive 16-item questionnaire, is designed to assess various symptoms related to extended screen time. Users complete the self-administered CVS-Q by indicating the frequency and intensity of 16 symptoms experienced during computer use. This allows for the calculation of a single symptom severity score (CVS score), with a score of six or more being indicative of the condition.

Scoring and Interpretation:

Each item in the CVS Q is typically scored on a scale that measures the frequency and severity of symptoms experienced such as eye fatigue, headache, blurred vision, double vision, itching eyes, dryness, tearing, eye redness and pain, excessive blinking, feeling of a foreign body, burning or irritation, difficulty in focusing for near vision, feeling of sight worsening, and sensitivity to light. The CVS-Q questionnaire measures the frequency of the above-mentioned symptoms with the response options of

Frequency:

- 0: Never
- 1: Occasionally
- 2: Often or Always

Intensity:

- 1: Moderate
- 2: Intense

The total score obtained by the formula:

Score $=\sum_{i=1}^{16}(frequency\ of\ symptoms\ occurence) \times (intensity\ of\ symptom)$

Respondents' scores across all items are then summed to obtain a total score, where higher scores indicate a greater severity of symptoms associated with computer vision syndrome. This total score helps in assessing the impact of digital screen use on eye health and identifying individuals at risk of CVS-related symptoms. If the total score is ≥6 points indicate a significant presence of Computer Vision Syndrome symptoms.

3. Statistical analysis

Table 1 presents the descriptive statistics, including the mean and standard deviation, calculated for the variables under study. Students were divided into two groups based on their scores from a self-developed questionnaire assessing screen time on mobile and digital devices. Group I comprised students with lower scores indicating more frequent and

prolonged device use, whereas Group II consisted of students with higher scores indicating less frequent digital device use. To assess the normality of the data distribution and the homogeneity of variances, Shapiro-Wilk (Table 2) and Levene's tests (Table 3) were employed, revealing violations of both assumptions. Consequently, the Mann-Whitney U test was employed to compare the ocular health such as eye strain problem between the two groups. Data analysis was performed using Jamovi version 2.4.

Table 1: Demographics and Mobile phone and digital devices usage of Adolescents

Parameters		Group I Mobile devices not being constantly used Screen time less (n=316)	Group II Mobile devices constantly used Screen Time greater (n=232)
Mean		6.07	7.54
Standard deviation		4.25	4.18
Gender	Male (262)	171(65.3%)	91(34.7%)
	Female (286)	145(50.7%)	141 (49.3%)

4. Results

4.1 Figure 1 shows percentage of participants reporting each CVS (Eye strain) symptom. Out of 232 students who use digital devices constantly,148 students suffer from the symptom of CVS. The most common symptoms experienced by the students were headache (37%), increased sensitivity to light (16%) and tearing (14%) while the least common symptoms were burning and eye pain (11%).

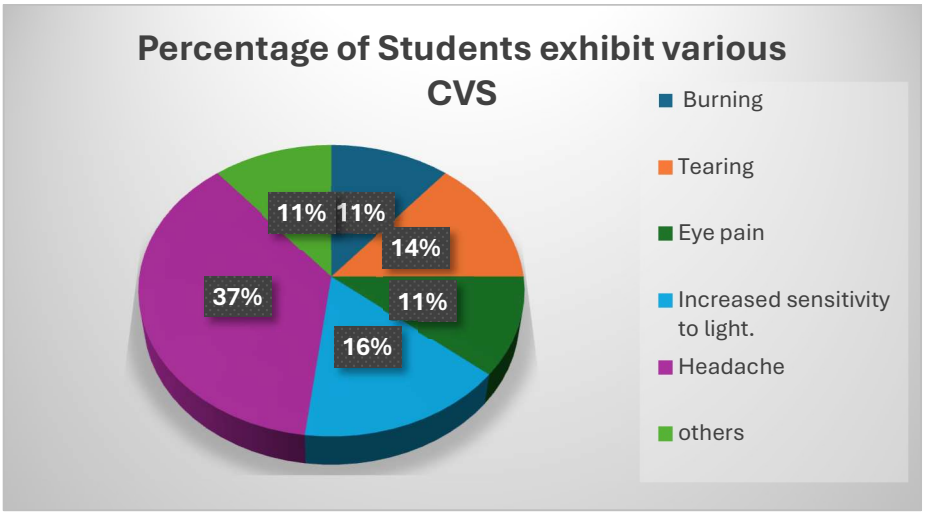

Figure 1: Percentage of participants reporting each CVS (Eye strain) symptom

To assess whether there is a significant difference between the groups, the following hypothesis has been proposed:

4.2 Null Hypothesis (H_0):

There will be no significant difference in the ocular health of adolescents who use digital devices frequently and those who do not.

Alternative Hypothesis (H_1):

There will be significant difference in the ocular health of adolescents who use digital devices frequently and those who do not.

Firstly, the data were assessed for normality and homogeneity using Shapiro-Wilk and Levene's test for Homogeneity of Variances Test. Descriptive statistic was used to describe the prevalence and awareness of CVS among adolescent students. Since the CVS scores were not normally distributed ($p<0.05$), Mann-Whitney test was used to compare the scores between the two groups. After applying statistical tools, the calculated value of p is greater than standard value (Standard value of alpha at 95% confidence interval is 0.05). Therefore, p value (<0.001) suggested the rejection of null hypothesis. Therefore, we can say that Adolescents who use digital devices frequently experience higher levels of ocular health issues, specifically eye strain, compared to those who do not use it.

Table 4(a): Independent Samples T-Test

Group	N	Mean	Standard Deviation	t -value
Group I	316(n1)	6.11	4.25	4.07
Group II	232(n2)	7.59	4.16	

Table 4(b): Mann Whitney Test Parameters

Eye strain (CVS)score	Statistic	Df	P - value	Mean difference	SE difference
Students t test	4.07	546	< .001	-1.48	0.364
Maan-Whitney test U	27921		< .001	-2.00	

Note. H_a $\mu_F \neq \mu_M$

[a] Levene's test is significant ($p < .05$), suggesting a violation of the assumption of equal variances

5. Discussions

Among adolescents using mobile and digital devices, 64% had eye strain (CVS). These findings are consistent with the results obtained by the Getzie, Harutyunyan, & Giloyan in 2020, where they found a 78.6% prevalence of CVS among the students at the American University of Armenia. Similar study performed by Rosenfield and Rosenfield (2020) found that approximately 70% of adolescents reported symptoms of digital eye strain, including eye fatigue, dryness, and headaches, primarily due to prolonged screen use.

In the current study, the most frequently reported symptoms of digital eye strain (CVS) among students were headaches (37%), increased sensitivity to light (16%), and tearing (14%), while burning and eye pain were the least common symptoms (11%). These findings are consistent with those reported by Rosenfield & Rosenfield (2020), Sheppard & Wolffsohn (2019), and Reddy & Singh (2021), who identified headaches and light sensitivity as common symptoms of digital eye strain and CVS, with tearing and eye pain occurring less frequently. Knuf & Schmidt (2022) also noted headaches, increased sensitivity to light, and eye discomfort as prevalent symptoms of digital eye strain, aligning with the results of the current study.

The current study indicates that adolescents who frequently use digital devices experience higher levels of ocular health issues, particularly eye strain, compared to those who use

digital devices less frequently. The results demonstrate a significant difference between these two groups. This finding is consistent with several studies, including Nair & Raman (2021), Chung & Kim (2019), Huang & Zhao (2021), Kim & Park (2020), Sankar & Sreenivas (2022), Moore & Tiwari (2021), and Patel & Johnson (2022), all of which reported that increased screen time is associated with greater visual discomfort among adolescents. Additionally, Ghosh & Debnath (2020) and Zhao & Liu (2021) found a significant correlation between frequent digital device use and symptoms of eye strain, with higher screen time linked to worse eye health outcomes.

While many studies indicate a strong association between frequent digital device use and increased eye strain or visual symptoms, some research has questioned or nuanced this connection. Few studies suggesting that frequent use of digital devices may not always significantly correlate with higher levels of eye strain or other visual symptoms. Studies such as Hollins & Alnawmasi (2021) found that while screen time is often cited as a cause of eye strain, the evidence linking high screen use to severe visual symptoms is not always consistent. Some participants did not report increased eye strain despite high screen usage. Miller & Foster (2018) indicated that while some studies find a correlation between digital device use and eye strain, the effect size is generally small, and many adolescents do not report significant symptoms. Lee & Kim (2020) showed that while short-term eye strain might increase with digital device use, long-term use did not necessarily lead to a significant increase in visual discomfort or eye strain symptoms. Jones & Anderson (2019) study found that the majority of participants who used digital devices frequently did not experience significant differences in eye strain compared to those with lower usage, suggesting other factors might contribute to symptoms. Thompson & Barlow (2020) found that while some adolescents reported eye strain, the relationship between device use and severe visual symptoms was not consistently significant across the population.

6. Conclusion

While digital devices offer numerous benefits to adolescents and children, they also pose significant risks to eye health due to prolonged use. It is imperative for parents, educators, and healthcare providers to be aware of these risks and implement strategies to mitigate them effectively. Digital devices have become ubiquitous in the lives of adolescents and children, presenting both opportunities and concerns regarding their impact on eye health, specifically in terms of eye strain. The current study examines existing research on the impact of prolonged digital device use on the eye health of young individuals. These studies highlight the need to raise awareness about ergonomic practices, reduce screen time when possible, and conduct further research to address new concerns in digital eye health. Educational interventions and ergonomic adjustments have been suggested to help alleviate eye strain among young users of digital devices. The National Institute for Occupational Safety and Health (NIOSH, 2012) recommends implementing proper lighting, using screen filters, and employing ergonomic furniture to minimize eye strain.

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