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A STUDY OF THE FREQUENCY AND DURATION OF ELECTRONIC DEVICE USE AMONG CHILDREN

Adilova Z.U.
Soatova F.I.
Tashkent State Medical University, School of public health

Annotation
In recent years, the rapid growth in the use of digital technologies – particularly smartphones, tablets, and computers – has led to a significant increase in visual system load among children, adolescents, and adults. This literature review focuses on the analysis of the development and progression of visual disorders associated with prolonged use of digital devices, including Digital Eye Strain (DES), Computer Vision Syndrome (CVS), refractive errors, and myopia.

Keywords: digital eye strain, computer vision syndrome, screen time, myopia.

Introduction

According to numerous studies, prolonged near work, reduced viewing distance between the eyes and digital screens, small font sizes, insufficient breaks, and decreased time spent outdoors contribute to the exacerbation of accommodative strain, asthenopia, and dry eye syndrome. The transition to online education during the COVID-19 pandemic resulted in a substantial increase in screen time, which further intensified the prevalence of DES and myopia among children and adolescents.

Research findings also indicate that individuals with presbyopia tend to prefer larger font sizes during reading tasks, whereas individuals without presbyopia

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usually read at shorter viewing distances, leading to a higher accommodative load. Several studies demonstrate the beneficial effects of vitamin-mineral complexes and antioxidants, including astaxanthin, in reducing eye fatigue and improving visual comfort. Overall, the available evidence confirms that rational use of digital devices, limitation of screen time, optimization of ergonomic visual conditions, and strengthening of preventive measures play a crucial role in maintaining visual health. In this study, viewing distance and font size were measured while participants read a simple text message on a smartphone in two groups: individuals without presbyopia (n = 157) and individuals with presbyopia (n = 60). The results showed that participants without presbyopia read at significantly shorter distances compared to those with presbyopia, which resulted in a marked increase in accommodative load. Individuals without presbyopia were found to read at shorter viewing distances compared to those with presbyopia, which results in a significantly higher accommodative load. In contrast, individuals with presbyopia tend to use larger font sizes, and this behavior becomes more pronounced when near-vision difficulties are identified using the Near Activity Visual Questionnaire (NAVQ, Italian version) [6].

A study conducted in the Qassim region of Saudi Arabia aimed to assess the prevalence of Digital Eye Strain (DES) among children attending online classes. This cross-sectional study was carried out among children aged 3 to 18 years residing in the Qassim region of Saudi Arabia. A self-administered questionnaire was distributed to parents of the targeted children through social media platforms, including WhatsApp (Meta Platforms, Inc., Menlo Park, California, USA), Telegram (Telegram FZ LLC, Dubai, UAE), and Twitter (Twitter, Inc., San Francisco, California, USA). The questionnaire comprised items related to sociodemographic characteristics, types of smart devices used, frequency of device use per day before and during the quarantine period, and symptoms of digital eye strain. A total of 547 children participated in the study, including 50.3% males and 49.7% females. Tablets were the most commonly used devices

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during online classes, accounting for 51.2% of usage. A statistically significant increase in device usage among children was observed during the COVID-19 - related quarantine period ($p < 0.001$). The prevalence of DES-positive symptoms was reported to be 69.8% [1].

Intensive use of professional video display terminals, personal computers, tablets, smartphones, and other digital gadgets is associated with both visual and physical discomfort. Common complaints include eye pain, a sensation of heaviness, fatigue, diplopia, blurred vision, and difficulty maintaining focus. This constellation of symptoms is referred to as Computer Vision Syndrome (CVS). Computer Vision Syndrome represents a complex of symptoms associated with the use of digital and computer-based electronic devices, combining features of accommodative (or mixed) asthenopia and dry eye syndrome. Clinically, this condition manifests as visual impairment and/or visual discomfort, glare, defocusing, accommodation disorders, fixation disparity, visual fatigue, ocular dryness, and general physical discomfort [3]. Globally, the prevalence of refractive errors has been estimated at approximately 12%, while visual impairment attributable to refractive errors accounts for about 2.1%. In sub-Saharan Africa, the prevalence of refractive errors and visual impairment due to refractive errors is reported to be 12.6% and 3.4%, respectively. In Ethiopia, the prevalence of visual impairment caused by refractive errors ranges from 2.5% in the Gurage zone to 12.3% in the Givassa region. Consequently, this meta-analysis aims to estimate the pooled prevalence of visual impairment due to refractive errors in Ethiopia [4].

Globally, the prevalence of refractive errors has been estimated at 12%, with visual impairment attributable to refractive errors affecting approximately 2.1% of the population. In sub-Saharan Africa, the prevalence of refractive errors and visual impairment due to refractive errors has been reported as 12.6% and 3.4%, respectively. In Ethiopia, visual impairment caused by refractive errors ranges from 2.5% in the Gurage zone to 12.3% in the Givassa region. Therefore, this

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meta-analysis aims to provide a comprehensive estimate of the overall prevalence of visual impairment due to refractive errors in Ethiopia [5].

Digital Eye Strain (DES) is a collection of ocular and visual symptoms resulting from prolonged use of digital devices, which can significantly impact the daily activities and learning of school-aged children. The primary objective of this study was to assess the prevalence of DES among schoolchildren in Palestine and to identify associated risk factors. Data regarding the types of digital devices used were collected, and DES was assessed using the Computer Vision Syndrome Questionnaire, while visual acuity was measured with the Snellen chart. Data analysis was performed using SPSS version 25 with 95% confidence intervals [2].

Symptoms in the first group may be associated with inadequately corrected ametropia (including astigmatism), presbyopia, persistent accommodative strain (refractive causes), fixation disparity, reduced convergence, increased accommodative lag, and impaired pupillary responses (ocular factors). Symptoms in the second group are linked to a reduced working distance between the eyes and the screen (particularly with handheld devices), font size, lighting conditions, screen positioning, and seating ergonomics. The third group of symptoms is related to decreased blink frequency and amplitude, contact lens (CL) wear, eyelid–lens interactions, and instability of the tear film (TF), including reduced tear production and alterations in its composition. These factors may result in blurred vision, glare, diplopia, eye fatigue, ocular heaviness and pain, headaches, and musculoskeletal strain in the neck, shoulders, and lumbar region. Additionally, ocular dryness, itching, irritation, foreign body sensation, epiphora, and periorbital redness may occur [10]. Visual functions, the Convergence Insufficiency Symptom Survey (CISS) scale, and additional questionnaires were also administered. Moreover, pre-COVID-19 axial length and refractive error data were obtained from outpatient records. The impact of strict home confinement on myopia was evaluated by comparing monthly axial elongation

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before the COVID-19 pandemic and during the period of strict home confinement. Spearman correlation analysis was performed to investigate the associations between potential influencing factors and the development of myopia [8].

With the continuous improvement of economic conditions and the rapid expansion of Internet access in different countries, adolescents are increasingly observed to use the Internet. Most studies have explored the relationship between Internet use and adolescent health; however, the potential mechanisms remain unclear, and few studies have focused specifically on Chinese adolescents. Adolescents exhibit distinctive patterns of Internet use that can affect their overall well-being. Our findings suggest that Internet use may negatively impact adolescent health, providing important insights into the relationship between Internet-use behavior and adolescent health, and highlighting the need for intervention regarding adolescents' Internet use [9].

Excessive screen time has been associated with childhood overweight and obesity, low physical activity, increased sedentary eating habits, poor dietary patterns, and sleep disturbances. Previous reviews have indicated that interventions targeting screen time can reduce screen exposure and improve behaviors linked to obesity. However, it remains unclear which research characteristics and behavior-modification techniques serve as the underlying mechanisms for the effectiveness of such interventions. The aim of this meta-analysis was to identify behavioral modification techniques and study features associated with the effectiveness of interventions aimed at reducing screen time among children aged 0–18 years [12]. The Sunflower Myopia Study conducted within the Asian Eye Epidemiology Consortium (AEEC) investigated the association between near-work activities, time spent in front of screens including television, and outdoor activity among children. The study found that increased reading and writing, coupled with decreased outdoor time, were associated with myopia. Screen time may substitute for near-work or outdoor activities; however,

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further research is required to evaluate its role as an independent risk factor for myopia. Among the children included in the study, 52.1% were boys, 98.1% were Chinese, and 69.7% resided in urban areas. The mean ± standard deviation (SD) by age was 8.8 ± 2.9 years, spherical equivalent (SE) was -0.14 ± 1.8 D, and axial length (AL) was 23.3 ± 1.1 mm. The prevalence of myopia was 30.6%.In multivariate analysis, greater reading and writing time (OR = 1.17; 95% CI, 1.11–1.24), longer overall time spent at work (OR = 1.05; 95% CI, 1.02–1.09), and reduced time outdoors (OR = 0.82; 95% CI, 0.75–0.88) were significantly associated with myopia ($p < 0.05$). These factors were similarly associated with SE and AL ($p < 0.05$), with the exception of total near-work and AL ($p = 0.15$). Time spent in front of a television screen was not significantly associated with myopia ($p = 0.49$), SE ($p = 0.49$), or AL ($p = 0.83$) [13]. This study examined the association between myopia and smartphone data usage. Young individuals now spend more time performing near tasks due to smartphone use, introducing an additional risk factor for the development and progression of myopia, which constitutes an important research question regarding potential strategies for myopia management. Elementary, middle, and high school students completed a questionnaire assessing smartphone usage patterns and their perceptions of myopia risk factors. Prolonged data usage recorded on the device was considered the primary and objective indicator of smartphone use. Average daily smartphone usage was also self-reported. Refractive status was confirmed by an optometrist [15].

This study also investigated the relationship between excessive digital media use in adolescents and negative health outcomes, specifically digital eye strain (DES) and poor sleep quality (PSQ). In a cross-sectional survey of 512 participants aged 11–18 years, DES and PSQ were evaluated using the Computer Vision Syndrome Questionnaire and the Pittsburgh Sleep Quality Index. A high prevalence of DES (63.7%) and PSQ (51.2%) was observed. Factors associated with DES included daily digital media use exceeding two hours, post-pandemic increases in digital

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media consumption, shorter breaks, and PSQ. Additionally, higher daily digital media use (>4 hours), bedtime usage, older age, female sex, online education, and DES were significantly correlated with PSQ. These findings underscore the detrimental effects of excessive digital media use on adolescent health, particularly in the post-COVID-19 context. The complex interrelationship between DES and PSQ highlights the need for public health interventions aimed at promoting healthy digital habits [16].

During the COVID-19 pandemic, children's regular daily activities were restricted due to the necessity of staying at home. Consequently, children were required to attend online classes provided by educational institutions at home. Subsequently, increased screen exposure led to complaints of blurred vision, headaches, and symptoms associated with Computer Vision Syndrome (CVS), predisposing them to myopia. This was a non-randomized, questionnaire-based study conducted in the ophthalmology department of a tertiary pediatric hospital. Participants were parents of children aged 6–16 years attending regular schools. After registration, parents completed an online consent form in English, followed by a Google Form interview. Eligible participants were recruited through multiple social media groups, notably WhatsApp and email. The COVID-19 quarantine substantially altered schoolchildren's lifestyles by significantly reducing outdoor activities and increasing time spent on online activities, fully supporting recommendations to limit online screen time and encouraging students to engage in regular outdoor activities [17].

Excessive smartphone use has been identified as a modifiable risk factor that may lead to reduced visual function. However, reports regarding the association between excessive smartphone use and visual impairment remain contradictory. Prolonged smartphone use, particularly in children, can increase the likelihood of ocular symptoms such as myopia, asthenopia, and ocular surface disorders. Therefore, regulating smartphone usage time and limiting prolonged use may help prevent visual and ocular symptoms. Further research on usage patterns and

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long-term observational studies can aid in developing detailed guidelines and recommendations for smartphone use among children and young adults [9].

A study investigating visual changes in school-aged children, including the prevalence of myopia, hyperopia, visual impairment, and spherical equivalent refraction (SER) before and after the coronavirus disease (COVID-19) pandemic, was conducted. Methods: School vision screening was performed on 133 primary school children in Wuhan over four consecutive years (2018–2021). A total of 468,094 children (936,188 eyes) participated, of whom 255,863 (54.7%) were boys. SER decreased in 2020 compared to other post-10-year periods. In 2020, positive myopic changes were observed in children aged 6 (0.1 D), 7 (0.05 D), and 8 (0.03 D) compared to 2019. Visual development showed slight improvement in 2021. Among the students included, 33.7% were affected by myopia. During the COVID-19 era, older children exhibited a significant decline in visual acuity, and they remain at high-risk post-pandemic. Future vision prevention and control efforts should particularly focus on preschool-aged children [19].

Globally, the prevalence of refractive errors is 12%, with visual impairment due to refractive errors affecting 2.1% of the population. In sub-Saharan Africa, the prevalence of refractive errors and associated visual impairment is 12.6% and 3.4%, respectively. In Ethiopia, visual impairment due to refractive errors ranges from 2.5% in the Gurage zone to 12.3% in Gavassa. Accordingly, this meta-analysis aimed to generalize the overall prevalence of visual impairment due to refractive errors in Ethiopia. Approximately 1,664 studies were retrieved from initial electronic searches using international databases and Google. A total of 20,088 children and adolescents were included in this meta-analysis. Using a random-effects model, the overall prevalence of visual impairment due to refractive errors in Ethiopia was estimated at 6% (95% CI, 5–7), with significant heterogeneity ($I^2 = 94.4\%$; $p < 0.001$). The prevalence was further analyzed by subtype, with overall prevalence estimates for myopia, hyperopia, and

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astigmatism of 4%, 5.2%, and 1%, respectively [6]. Myopia is becoming increasingly prevalent worldwide. It is an often-overlooked but major cause of blindness, particularly among the working-age population. Myopia is frequently considered benign because it can be easily corrected with glasses, contact lenses, or refractive surgery. Traditionally, myopia has been classified into physiological and pathological subtypes, depending on the degree of refractive error. High myopia is associated with an increased risk of pathological complications; however, it is important to note that no level of myopia is entirely safe. Even low-grade myopia increases the risk of retinal detachment and other ocular diseases, which will be discussed in more detail later. The most severe complication, myopic maculopathy, is the leading cause of blindness in untreated cases and inevitably leads to vision loss in some individuals, even at a young age [7].

In recent years, there has been a significant increase in the prevalence of myopia (near-sightedness) among children and adolescents. This trend is largely attributed to the increased visual load and prolonged daily use of digital devices. Furthermore, inadequate intake of essential vitamins and micronutrients in this age group may lead to deficiencies, emphasizing the importance of sufficient antioxidant and nutritional support to protect photoreceptors. Data are available on the prevalence of vitamin and antioxidant deficiencies in children aged 3–6 years and 7–17 years. Several studies confirm that regular supplementation with vitamin-mineral complexes (VMCs) containing lutein, zeaxanthin, B-group vitamins, vitamins C, E, D, and trace elements over several months improves the functional activity of retinal cells [14]. This study evaluated the effect of astaxanthin supplementation on chronic and acute eye fatigue in school-aged children (10–14 years) and assessed its safety. While previous research focused on adults, this study examined the effects of astaxanthin on developing eyes. Astaxanthin supplementation effectively reduced both chronic and acute eye fatigue, thereby improving objective measures of visual function in school-aged children and highlighting the benefits of astaxanthin for children's visual health

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and performance. A randomized, double-blind, placebo-controlled trial was conducted with 64 children who spent ≥ 4 hours daily in front of screens and exhibited mild-to-moderate computer vision syndrome (CVS) symptoms, with CVS-Q scores ≥ 8 and < 19. Participants received 4 mg of astaxanthin softgel daily for 84 days. Primary outcomes were assessed using the CVS-Q, while secondary outcomes included the Visual Fatigue Likert Scale (VFLS), visual acuity, spherical equivalent, near accommodation point, exophoria, dry eye intensity, pupil size, stereopsis, blinking frequency, immunity, and safety variables [11].

Conclusion

Analysis of the literature indicates that both the frequency and duration of electronic device use among children and adolescents have increased substantially in recent years, particularly during the COVID-19 pandemic. Prolonged use of smartphones, tablets, and computers at close distances has resulted in increased accommodative strain and widespread incidence of digital eye strain (DES) and computer vision syndrome (CVS) symptoms. Studies report that DES symptoms among children may reach 60–70%, manifesting as blurred vision, eye fatigue, headaches, and dry eyes. Additionally, increased near-work, reduced distance between the eyes and the screen, insufficient breaks, and decreased outdoor activity are strongly associated with the development and progression of myopia. Extensive epidemiological studies and meta-analyses confirm the increasing prevalence of myopia and other refractive errors among children and adolescents. Moreover, adherence to ergonomic viewing conditions, limiting screen time, taking regular breaks, and increasing outdoor activity are important preventive measures to reduce visual discomfort and fatigue. Several studies also report the beneficial effects of vitamin-mineral complexes and antioxidants, including astaxanthin, in reducing eye fatigue and supporting visual function. Overall, the development and implementation of preventive strategies

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for the rational use of electronic devices play a crucial role in maintaining children's visual health.

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