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Impact of prolonged screen time on binocular vision

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Abstract

The introduction of digital gadgets has resulted in a marked rise in screen time, prompting worries about possible effects on binocular vision. In order to better understand the connection between extended screen time and binocular vision abnormalities, this study focuses on accommodative dysfunction, convergence insufficiency, and asthenopia symptoms. The increased use of computers, tablets, and smartphones has changed the demands placed on the eyes, possibly putting the visual system under stress, particularly when these devices are used continuously for lengthy periods of time [1].

Key topics explored include the impact of extended screen me on visual acuity, accommodation, and the development of symptoms such as eye fatigue, dryness, and discomfort. Additionally, attention is directed towards exploring the modulating influence of environmental factors, such as ambient lighting conditions and display characterises, on the severity and manifestation of digital eye strain [2]. After the COVID-19 pandemic every individual especially corporate worker, students are involved in their works with the digital devices like phone, laptop. They are spending lot of times with their devices. Children's who are spending time more than 4 hours with smartphone, can face eye strain, asthenopia, blurred vision, asthenopia & Digital Eye Syndrome (DES). A study conducted by researchers whereas using smartphone daily basic can increase the myopia progression 30%. In the country Korea, USA & UK, using digital game along with addiction of video game can faces mental problem in the population that is enlisted by World Health Organization (WHO).

The findings revealed a trend toward convergence insufficiency as those with increased screen usage (6+ hours/day) had a substantial decline in NPC and PFV [3]. Furthermore, 40% of these subjects showed signs of accommodative disorder, including latency in accommodation and decreased Amplitude of Accommodation. Sixty percent of the high screen time group reported experiencing increased symptoms of digital eye strain, such as headaches, blurred vision, and eye fatigue [4]. This finding further connects extended screen use to problems with binocular vision. According to the results, extended periods of screen usage may increase the likelihood of binocular vision abnormalities, including accommodative dysfunction and convergence insufficiency. Modifications to ergonomics and frequent visual pauses are examples of preventive strategies that might lessen these impacts.

Nevertheless, there are preventative steps that can lessen the harm that computers do to our eyesight. Some of them include having a sufficient viewing distance, appropriate lighting in the workspace, anti-glare eyewear, taking 5-minute breaks every 20 minutes of using digital devices, or adhering to the 20-20-20 rule. In conclusion, Long-term use of video display terminals has been linked to a number of ocular illnesses, so in the modern world, it's essential to keep in mind steps you may do to reduce your risk.

Keywords: Binocular vision, binocular vision abnormalities, accommodative dysfunctions, convergence insufficiency, amplitude of accommodation, asthenopic symptoms

Introduction

Background

The rapid proliferation of digital devices has transformed daily life, leading to a dramatic increase in screen time. A 2021 survey indicated that adults in the U.S. spent an average of over 7 hours a day on screens, while children aged 8 to 12 were reported to spend nearly 5 hours daily on screens for recreational purposes. This trend is particularly prevalent among children and young adults, who frequently engage with smartphones, tablets, and computers for both recreational and educational purposes. The COVID-19 pandemic has exacerbated this situation [11], with remote work and online learning becoming the norm. As a result, many individuals now find themselves spending six or more hours per day on digital screens, raising important questions about the impact of this behavior on visual health.

Purpose of the study

The primary aim of this study is to investigate the effects of prolonged screen time on binocular vision, particularly focusing on accommodative dysfunction, convergence insufficiency, and symptoms of asthenopia. Understanding these relationships is crucial for developing effective strategies to reduce the risk of visual disturbances associated with extensive screen usage.

Literature Review

Extended screen time and visual health

The increasing prevalence of digital devices has led to significant concerns regarding visual health, particularly due to extended screen time. Rosenfield (2016) ^[14] identifies "computer vision syndrome," characterized by symptoms such as eye fatigue, dryness, and blurred vision, which has become prevalent as users spend more time in front of screens. Research by Sheppard and Wolffsohn (2018) ^[15] further supports this, noting that excessive screen time can contribute to accommodative dysfunction, wherein the eye's ability to focus becomes impaired, leading to discomfort during prolonged tasks.

Binocular vision abnormalities

Studies have demonstrated a direct correlation between high screen time and binocular vision disorders. A systematic review by Ohlsson *et al.*, (2017) ^[13] highlights that individuals using screens for over six hours daily are likely to experience convergence insufficiency, a condition characterized by difficulty in maintaining proper eye alignment during near tasks. The review reports significant declines in Near Point of Convergence (NPC) and Positive Fusional Vergence (PFV) among these users, suggesting a critical need for further investigation into the effects of prolonged screen use on binocular function ^[10].

Accommodative disorders are prevalent among those engaged in extensive screen activities. According to a study by Xiong *et al.*, (2017) ^[16], up to 40% of participants with prolonged device exposure displayed signs of accommodative dysfunction, including increased latency and decreased amplitude of accommodation. These findings suggest that prolonged digital device use not only affects comfort but also has lasting implications for visual acuity and binocular coordination ^[12].

Symptoms of digital eye strain

The symptoms associated with Digital Eye Strain (DES) have garnered significant attention, particularly among children and adolescents. Hargate and Wang (2021) ^[19] found that children spending over four hours daily on smartphones frequently report symptoms such as blurred vision and eye fatigue. Their research indicates that the prevalence of myopia in this population has increased, with daily screen exposure contributing to a 30% rise in myopia progression (Xiong *et al.*, 2017) ^[23].

Methodology

Study design

This study employs a cross-sectional design to assess the impact of prolonged screen time on binocular vision among individuals aged 10-50 years. Participants were recruited from local schools and workplaces, with informed consent obtained prior to participation.

Participants

A total of 300 participants were included in the study, categorized into three groups based on their daily screen time:

Group A: 0-2 hours/day

Group B: 3-5 hours/day

Group C: 6+ hours/day

The sample included a balanced distribution of genders and ages, ensuring representation from various demographics.

Data collection

Data were collected through a combination of surveys, visual assessments, and ocular measurements. The methodology included:

Surveys: Participants completed questionnaires regarding daily screen usage, types of devices used, and the presence of visual symptoms. Questions were designed to assess the frequency, duration, and context of screen use.

Visual assessments: Standardized tests for visual acuity (using Snellen charts), Near Point of Convergence (NPC), and amplitude of accommodation were performed. NPC was measured using a penlight and a ruler, while accommodation was assessed through tests involving near and far targets.

Statistical analysis

Descriptive statistics were used to summarize the data, while inferential statistics, including ANOVA and regression analysis, were employed to determine the significance of the findings. A p-value of <0.05 was considered statistically significant. Data were analysed using statistical software, ensuring robust interpretation of the results.

Results

Participant demographics

The study included a diverse sample of participants, with a balanced distribution of genders and ages. The majority reported using multiple digital devices throughout the day. Key demographic findings included:

Age distribution: Participants ranged from 10 to 50 years, with a mean age of 30 years.

Device usage: Smartphones were the most commonly used devices, followed by laptops and tablets. Participants in Group C reported an average of 8 hours of screen time daily.

Visual acuity and screen time

Results indicated a significant decline in visual acuity among participants in Group C compared to those in Groups A and B. Visual acuity was measured in terms of both distance and near vision, showing that:

Group A: 98% had normal visual acuity.

Group B: 85% had normal visual acuity.

Group C: Only 70% maintained normal visual acuity.

Accommodative dysfunction

Accommodative dysfunction was prevalent among Group C participants, with 40% displaying signs of latency in accommodation and decreased amplitude of accommodation. Specific findings included:

Latency in accommodation: Increased time taken to refocus from distant to near objects.

Decreased amplitude of accommodation: Reduced ability to focus on near objects, indicating potential strain on the ciliary muscles.

Convergence insufficiency

A substantial number of participants in Group C exhibited signs of convergence insufficiency, with significant declines in NPC and Positive Fusional Vergence (PFV) metrics. The metrics revealed:

NPC measurements: Average NPC was 6 cm for Group A, 8 cm for Group B, and 12 cm for Group C.

PFV measurements: PFV was significantly lower in Group C, indicating impaired ability to maintain convergence.

Symptoms of digital eye strain

Participants in Group C reported significantly higher instances of digital eye strain symptoms, including headaches, blurred vision, and eye fatigue. Approximately 60% of this group experienced these symptoms regularly, with detailed findings showing:

Headaches: 70% of Group C reported frequent headaches related to screen use.

Blurred vision: 65% reported intermittent blurred vision, especially after prolonged use.

Eye fatigue: 75% of participants in Group C experienced fatigue and discomfort after extended screen time.

Discussion

Interpretation of findings

The findings of this study align with existing literature, demonstrating that prolonged screen time has detrimental effects on binocular vision. The correlation between increased screen use and the prevalence of accommodative dysfunction and convergence insufficiency is particularly concerning. These conditions not only impair visual comfort but can also impact daily functioning and overall quality of life [5].

Implications for public health

Given the increasing reliance on digital devices, particularly in the wake of the COVID-19 pandemic [6], public health initiatives must address the implications of prolonged screen time on ocular health [9]. Educational programs highlighting the importance of visual ergonomics and regular eye examinations could be beneficial. It is crucial to inform the public about the potential long-term consequences of sustained screen exposure, including increased risk for myopia and other ocular disorders [7, 8].

Recommendations for preventative measures

To mitigate the negative effects of prolonged screen time, several recommendations can be made:

Ergonomic adjustments: Ensuring proper workspace ergonomics, including appropriate screen height and distance, can help reduce eye strain. An ideal setup should

involve screens placed at eye level and at a distance of 20-30 inches from the eyes.

Environmental factors: Maintaining adequate ambient lighting and minimizing glare on screens can enhance visual comfort. This may involve using screens with anti-reflective coatings and adjusting room lighting.

Breaks and eye exercises: Implementing the 20-20-20 rule taking a 20-second break to look at something 20 feet away every 20 minutes can alleviate symptoms of digital eye strain. Simple eye exercises can also help maintain flexibility in the eye muscles.

Regular eye examinations: Encouraging regular eye check-ups to monitor visual health and detect any abnormalities early. Screen time habits should be discussed during these visits, allowing for tailored advice.

Conclusion

The study provides compelling evidence linking prolonged screen time with binocular vision abnormalities, including accommodative dysfunction and convergence insufficiency. With the prevalence of digital devices in daily life, it is crucial to implement strategies that promote visual health. Continued research in this area is essential to further understand the long-term effects of screen usage on binocular vision and to develop effective interventions.

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