

Digital Eye Strain and its Impacts on Vision

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Abstract

Digital eye strain, also known as computer vision syndrome, is a prevalent condition affecting individuals who spend extended periods using digital devices. This article undertakes an exploration of the symptoms, causes, and solutions associated with digital eye strain. This writer will utilize existing literature to provide a comprehensive understanding of the impact of prolonged digital device use on vision and proffer insights into effective management strategies.

Introduction

The integration of digital devices into every facet of our daily lives has changed the way we work, communicate, and entertain ourselves [1]. From smartphones and tablets to computers and e-readers, these devices have become very indispensable. The Journal of family medicine and primary care reports that the advantages of digital technology are abundant, nevertheless, the consequential impact on ocular health has become a topic of increasing concern [2]. This necessitates the need for an investigation of the implications of extended screen time on visual health.

The North Carolina Optometric Society describes digital eye strain as ‘a group of eye and vision- related problems that result from prolonged computer, tablet, e-reader and cell phone use [3]. Digital eye strain, also referred to as computer vision syndrome, is descriptive of a range of ocular discomfort and visual disturbances experienced during or after the use of digital devices. The symptoms range from eye fatigue, dryness, and headaches to blurred vision and neck pain.

Causes of digital eye strain

Several interrelated factors contribute to the development of digital eye strain, ranging from screen exposure, lighting conditions, ergonomic practices, and even the seemingly less harmful act of blinking. Briefly, this writer will discuss the causes of digital eye strain.

Prolonged screen exposure

An internet report records that ‘globally people average 6 hours and 58 minutes of screen time per day. Daily screen time has increased by nearly 50 minutes per day since 2013. The average American spends 7 hours and 4 minutes looking at a screen each day and South Africans spend 10 hours and 46 minutes on screen per day [4]. The ubiquity of digital screens exposes individuals to prolonged periods of screen time, whether for work, education, or recreation.

Additionally, the human visual system is not evolutionarily adapted to sustained focus on close- up tasks, such as reading or staring at screens for extended durations [5]. Prolonged screen exposure contributes to eye fatigue, blurred vision, and dryness, collectively defining the major symptoms of digital eye strain. Furthermore, the visual demands imposed by digital screens challenge the accommodative and vergence systems and this leads to visual discomfort.

Improper lighting conditions

The role of lighting conditions cannot be overstated in a discourse on digital eye strain. Inadequate ambient lighting or excessive glare from screens cause visual discomfort [6]. Insufficient lighting prompts

users to strain their eyes to discern text and images, while excessive brightness or glare causes discomfort and contributes to glare-induced symptoms. An optimal balance in lighting, considering both screen brightness and environmental illumination, is very important when considering minimizing visual stress and preventing the onset of digital eye strain.

Poor ergonomic practices

The American Academy of Ophthalmology records that the ergonomics of the workspace and device usage influences the development of digital eye strain very significantly [7]. Improper posture, non-ergonomic furniture, and non-adjustable screen positions contribute immensely to neck pain, shoulder tension, and eye discomfort. Seemingly, suboptimal ergonomic setups often lead to prolonged awkward postures and this increases the strain on the visual and musculoskeletal systems.

Reduced frequency of blinking

Blinking is a natural and reflexive mechanism that moistens the eyes and spreads a protective tear film [8]. However, when engrossed in digital activities, individuals often exhibit a reduced frequency of blinking. The aftermath of this is an inadequate lubrication of the ocular surface. This phenomenon, known as computer vision-related dry eye, heightens the risk of discomfort, irritation, and blurred vision.

Symptoms of digital eye strain

Eye fatigue: Eye fatigue, or asthenopia, is a symptom of digital eye strain [9]. Prolonged periods of focusing on digital screens strain the eye muscles responsible for accommodation and convergence. As a result, individuals experience a sensation of tiredness, heaviness, or aching in the eyes. Eye fatigue escalates with continued screen exposure. This is a sure way to diminished visual performance and overall discomfort.

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Dryness and irritation: Extended use of digital devices often correlates with a reduction in the frequency of blinking, and this results in insufficient lubrication of the eyes [10]. This, in turn, contributes to symptoms of dryness, irritation, and a gritty sensation. The compromised tear film often leads to discomfort, redness, and a feeling of foreign body presence.

Headaches: Headaches are a common consequence of digital eye strain and are often associated with both eye-related and systemic factors. The visual demands imposed by screens create room for tension-type headaches, particularly in the forehead and temples. Eye strain, muscle tension, and the impact on the trigeminal nerve contribute greatly to headache symptoms.

Blurred vision: Blurred vision is a symptom of digital eye strain, that fluctuates in intensity and duration. Prolonged near work leads to temporary changes in visual acuity, and this makes it extremely challenging for individuals to maintain clear and focused vision. This symptom can be particularly very disruptive during tasks that require sustained visual attention, such as reading or working on a computer.

Impacts on daily activities and productivity

The symptoms of digital eye strain go beyond mere physical discomfort. It has an overwhelming impact on daily activities and productivity. Individuals experiencing eye fatigue and headaches find it very challenging to sustain focus during work or academic tasks. The discomfort associated with dry eyes can be very distracting, impeding concentration and reducing overall efficiency. Blurred vision further worsens the challenge by hindering performance in tasks that demand visual precision, such as reading fine print or interpreting data on a screen.

Additionally, the cumulative effect of these symptoms leads to heightened stress levels and decreased job satisfaction. With the prevalence of remote work and digital learning, the negative impact on productivity becomes more pronounced.

Diagnostic criteria and differentiation

Eye health practitioners utilize a combination of clinical assessments and patient-reported symptoms to diagnose digital eye strain. The diagnostic criteria include a thorough examination of visual acuity, refraction, binocular vision, and accommodative function. Optometrists also assess ocular surface health and inquire about specific symptoms related to digital device use.

Differentiating digital eye strain from other vision-related issues involves ruling out underlying ocular conditions such as refractive errors, accommodative disorders, and dry eye syndrome. Additionally, a comprehensive patient history, including detailed information about digital habits, occupational requirements, and environmental factors, aids in identifying the unique characteristics of digital eye strain. The use of symptom questionnaires and subjective assessments complements objective clinical findings.

Blue light and digital eye strain

Digital screens emit a significant amount of blue light. A report posits that 'smartphones may have between 400 and 490 nm of blue light'. This raises concerns about its impact on ocular health and overall well-being. The role of blue light in contributing to digital eye strain, delving into relevant studies on its effects on retinal cells and circadian rhythms will be analyzed.

Additionally, an examination of the current evidence surrounding

the efficacy of blue light-filtering lenses and screen filters in mitigating these effects will be undertaken.

Blue light and retinal cells

Blue light, with wavelengths ranging from 380 to 500 nanometers, is a component of the visible light spectrum emitted by digital screens. Studies have investigated the effects of blue light on

retinal cells, particularly the photoreceptors in the retina. Research suggests that prolonged exposure to blue light may contribute to oxidative stress in retinal cells, increasing the risk of age-related macular degeneration (AMD).

A study published in the "Journal of Photochemistry and Photobiology B: Biology" (2018) found that blue light exposure led to increased production of reactive oxygen species (ROS) in retinal cells, suggesting a potential link between blue light exposure and cellular damage. However, the precise mechanisms and the clinical significance of these findings warrant further investigation.

Blue light and circadian rhythms

Blue light plays a vital role in regulating circadian rhythms and sleep-wake cycles. Exposure to blue light, especially in the evening, can suppress the production of melatonin, a hormone that regulates sleep. The use of digital devices emitting blue light before bedtime may disrupt circadian rhythms. This can lead to difficulties falling asleep and reduced overall sleep quality.

Research published in "Proceedings of the National Academy of Sciences" (2015) demonstrated that exposure to blue light significantly suppressed melatonin production and led to increased alertness compared to exposure to dim light. This underscores the importance of understanding the impact of blue light on sleep patterns and the importance of managing exposure, especially during the evening hours.

Efficacy of blue light filtering lenses and screen filters

To address concerns about the adverse effects of blue light, manufacturers have developed blue light-filtering lenses and screen filters. These technologies aim to reduce the amount of blue light reaching the eyes and, in turn, mitigate ocular and circadian effects.

While some studies suggest that blue light-filtering lenses may be effective in reducing symptoms of eye strain and improving sleep quality, the overall evidence is mixed. A study in the "Journal of Ophthalmic and Vision Research" (2017) found that blue-blocking spectacle lenses improved visual comfort and reduced symptoms of eye fatigue during prolonged computer use. However, more research is needed to establish the long-term efficacy of these interventions and their impact on ocular health.

Screen filters that reduce blue light emission from digital devices have also gained popularity. Studies, such as one published in "Sleep Medicine Reviews" (2017), suggest that using screen filters or applications that decrease blue light exposure in the evening can positively influence sleep patterns.

Prevention and management strategies for digital eye strain

The 20-20-20 rule: The 20-20-20 rule is a simple yet effective strategy to reduce eye strain during prolonged digital device use. The rule suggests taking a break every 20 minutes, looking at an object 20 feet away, and maintaining this gaze for at least 20 seconds. This brief

pause allows the eyes to relax and refocus, hereby reducing the strain imposed by sustained near work.

Proper screen positioning: Optimal screen positioning is integral to reducing visual strain and promoting comfortable viewing. Screens should be positioned at eye level, maintaining a distance of about arm's length from the eyes. Additionally, the screen angle should be adjusted to minimize glare and reflections. Proper positioning does not only reduce the physical demands on the eyes but also contributes to overall ergonomic comfort, and this prevents neck and shoulder strain.

Adjustments to lighting conditions: Adequate ambient lighting, avoiding glare, and minimizing reflections on screens contribute greatly to visual comfort. Adjusting screen brightness to match the ambient lighting level helps to reduce visual stress. Natural light sources are preferable, and the use of task lighting for reading or working on specific tasks further enhances the visual experience.

Artificial tears: The use of artificial tears provides relief from dryness and discomfort associated with digital eye strain. Prolonged screen use often leads to reduced blinking, resulting in inadequate lubrication of the eyes. Artificial tears replenish the tear film, by keeping the ocular surface moist and reducing symptoms of dryness and irritation. Regular use of preservative-free artificial tears is recommended, especially in environments with low humidity or prolonged air-conditioned settings.

Specialized computer glasses: Computer glasses with specialized coatings or tints designed to reduce glare and filter blue light give additional protection against digital eye strain. Blue light-blocking coatings help to minimize disruptions to circadian rhythms and mitigate the impact of blue light on retinal cells. These glasses are tailored for the intermediate viewing distance associated with digital devices so as to provide visual comfort during screen use.

Future directions and research needs in digital eye strains

As global reliance on digital devices increases, digital eye strain concerns demand constant innovation. Research initiatives will aid understanding of this phenomenon and develop effective solutions. Additionally, the integration of emerging technologies, such as virtual reality (VR) and augmented reality (AR), opens new avenues for both research and intervention.

Ongoing research initiatives: Ongoing research initiatives are very important for advancing an understanding of digital eye strain, refining diagnostic criteria, and exploring novel interventions. Researchers are currently investigating the long-term effects of digital screen exposure on ocular health, including the correlation between digital eye strain and the development of myopia, dry eye syndrome, and other vision-related conditions. The impact of blue light, screen flicker, and individual susceptibility factors are also areas of active investigation. Collaborative efforts between optometrists, ophthalmologists, and researchers aim to establish evidence-based guidelines for the diagnosis and management of digital eye strain.

Virtual reality and augmented reality: VR and AR have introduced a paradigm shift in digital interactions; this warrants an exploration of their impact on ocular health. Current research is investigating the role of VR and AR in both exacerbating and mitigating digital eye strain. Studies are underway to assess the ocular effects of prolonged VR/AR use, including their influence on accommodation, vergence, and other visual parameters. Conversely, researchers are exploring the incorporation of these technologies in vision therapy and ergonomic

interventions to enhance visual comfort during extended use of digital interfaces.

Gaps in the current literature: Strides have been made in understanding digital eye strain, not withstanding, several gaps persist in the current literature. Longitudinal studies tracking the ocular health of individuals with sustained digital device use over extended periods are needed to elucidate the cumulative effects and potential progression of digital eye strain. The impact of digital eye strain on specific populations, such as children, older adults, and individuals with pre-existing ocular conditions, remains an area requiring focused investigation. Furthermore, the varying methodologies across studies hinder direct comparisons and necessitate standardized approaches for assessing symptoms and interventions.

Avenues for future investigation: Future research should investigate the customization of preventive and therapeutic strategies based on individual characteristics, including age, refractive status, and visual demands. Exploring the benefits and risks associated with blue light-filtering technologies, including both lenses and screen filters, requires very rigorous investigation. The development of evidence-based guidelines for blue light exposure limits, especially in emerging digital technologies, is very important for informing public health recommendations. Moreover, the integration of artificial intelligence (AI) in the assessment and management of digital eye strain presents an exciting avenue for further investigation. AI applications that analyze eye movement patterns, blink rates, and other ocular parameters could provide personalized recommendations for reducing eye strain and optimizing visual comfort.

Conclusion

In summary, this article has systematically addressed the symptoms, causes, and management strategies associated with digital eye strain. The key findings underscore the imperative for heightened awareness, implementation of preventive measures, and the adoption of evidence-based interventions to address this prevalent issue. The symptoms of digital eye strain, including eye fatigue, dryness, headaches, and blurred vision, are indicative of the adverse consequences stemming from prolonged digital screen exposure. Recognizing the nuanced causes, such as blue light emission, poor ergonomics, and reduced blinking frequency, provides a foundation for targeted interventions. The significance of implementing preventive measures, including the widely advocated 20-20-20 rule, optimal screen positioning, and adjustments to lighting conditions, cannot be overstated. These measures, when integrated into daily practices, contribute to reducing visual discomfort and preventing the cumulative effects of extended digital device use. Evidence-based interventions, such as artificial tears, specialized computer glasses, and ergonomic adjustments, offer tailored solutions to alleviate symptoms and address the diverse needs of individuals. Their inclusion in ocular health strategies is vital for effective management and prevention of long-term complications associated with digital eye strain. In light of these findings, a collective call to action is extended to optometrists, researchers, and policymakers. Optometrists are urged to integrate these insights into clinical practice, ensuring that patient care is fortified with informed strategies against digital eye strain. Researchers are encouraged to pursue further investigations, addressing gaps in current literature and exploring emerging technologies to deepen our understanding and refine interventions. Policymakers play an important role in recognizing the public health significance of digital eye strain. Collaboration among optometrists, researchers, and policymakers is essential to formulate

guidelines, implement preventive measures, and minimize the impact of prolonged digital device use on visual health. By aligning efforts, a comprehensive approach can be fostered, mitigating the challenges posed by digital eye strain and safeguarding the visual well-being of individuals in the digital landscape.

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