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ORIGINAL RESEARCH

Assessment of Visual Fatigue While Watching Digital Screens

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ABSTRACT
Background: Prolonged exposure to digital screens has led to an increase in visual fatigue, commonly referred to as digital eye strain (DES). This condition encompasses symptoms such as eye discomfort, dryness, blurred vision, and headaches, significantly impacting daily productivity and well-being.**Objective:** This study aims to assess the prevalence and severity of visual fatigue among digital screen users, identify contributing factors such as screen time, device type, and environmental conditions, and evaluate the effectiveness of preventive measures.**Methods:** A cross-sectional study was conducted with 185 participants aged 18–55 years. Data were collected using a structured questionnaire to gather demographic information, screen usage patterns, and self-reported symptoms of visual fatigue. An observational checklist was used to validate environmental conditions. Data were analyzed using descriptive statistics, Pearson's correlation, regression analysis, and chi-square tests.**Results:** Visual fatigue was reported by 82% of participants, with 22% experiencing severe symptoms. Common symptoms included eye discomfort (78%), dryness (65%), and blurred vision (50%). Laptops and smartphones were associated with higher symptom scores compared to desktops and tablets. Poor lighting and improper screen positioning significantly increased symptom severity. Preventive measures, such as the 20-20-20 rule and blue light filters, were effective in reducing symptoms, yet awareness and implementation of these strategies were limited.**Conclusion:** The study concludes that visual fatigue is a widespread concern linked to screen usage patterns and environmental factors. Increasing awareness and promoting preventive practices can mitigate symptoms and improve visual health in a screen-dependent society. Further research is recommended to explore long-term impacts and advanced interventions.
Keywords: Visual Fatigue, Digital Eye Strain (DES), Screen Time, Blue Light, Digital Devices, Environmental Factors

INTRODUCTION

In the contemporary digital landscape, the integration of technology into virtually every aspect of life has led to an unprecedented increase in screen exposure. From smartphones and laptops to tablets and smart TVs, digital devices have become essential tools for communication, education, work, and entertainment [1]. However, the widespread reliance on these devices has brought with it a new set of health challenges, particularly related to visual health. Visual fatigue, often referred to as digital eye strain (DES), is one of the most prevalent issues faced by individuals of all ages due to prolonged screen usage. Characterized by a collection of symptoms such as eye discomfort, dryness, blurred vision, headaches, and difficulty concentrating, visual fatigue has become a growing concern in modern society [2].

The underlying mechanisms of visual fatigue are complex and multifactorial. Prolonged focus on close-range objects, as required during screen use, places a strain on the ciliary muscles of the eyes, leading to accommodative stress [3]. This is further compounded by a significant reduction in blink rate during screen interaction, which can lead to inadequate tear film production and subsequent dryness of the eyes. Additionally, digital screens emit high-energy blue light, which has been linked to visual discomfort and potential disruption of circadian rhythms. The cumulative effect of these factors results in visual fatigue, which, if unaddressed, can contribute to long-term visual health problems [4].

Environmental and behavioral factors also play a critical role in the development of visual fatigue [5]. Poor lighting conditions, improper screen positioning, and lack of regular breaks exacerbate the strain on the eyes. Similarly, individual differences such as age, pre-existing eye conditions, and screen usage habits can influence the severity of symptoms. For instance, children and adolescents, whose eyes are still developing, may be more susceptible to the adverse effects of prolonged screen exposure [6]. Conversely, older individuals may experience exacerbated symptoms due to age-related changes in the eyes, such as reduced accommodative flexibility and dry eye syndrome [7].The rise of remote work and online education during the COVID-19 pandemic has further intensified the issue, with many individuals reporting significant increases in screen time. The shift to digital platforms for professional and academic activities has blurred the boundaries between work and leisure, leading to a continuous and often uninterrupted engagement with screens. This has raised urgent questions about the impact of prolonged digital screen exposure on visual health and overall well-being [8].Despite the growing prevalence of visual fatigue, awareness of its causes, symptoms, and prevention remains limited among the general population. Existing interventions, such as ergonomic guidelines, blue light filters, and the 20-20-20 rule (taking a 20-second break to view something 20 feet away every 20 minutes), have shown promise in mitigating symptoms. However, the effectiveness of these strategies varies, and there is a need for further research to identify more comprehensive solutions [9].

Objective

This study aims to investigate the extent and contributing factors of visual fatigue associated with digital screen usage. By assessing parameters such as screen type, viewing duration, ambient lighting, and individual habits, this research seeks to deepen the understanding of visual fatigue and its underlying causes.

Methodology

This cross-sectional study was conducted and involved 185 participants, selected to represent a diverse population aged between 18 and 55 years. Participants were recruited through convenience sampling from multiple sources. Individuals with pre-existing ophthalmologic conditions, neurological disorders, or recent eye surgeries were excluded to eliminate confounding factors. Participants with normal vision or corrected-to-normal vision to maintain consistency were included in the study.

Data Collection

Data were collected using a structured survey questionnaire and an observational checklist. The survey included questions covering demographic information, screen usage patterns, symptoms of visual fatigue, and the participants' awareness of preventive measures. Symptoms such as eye discomfort, dryness, blurred vision, and headaches were rated on a Likert scale ranging from 1 (no symptoms) to 5 (severe symptoms). The observational checklist validated self-reported data by examining posture, screen positioning, and lighting conditions in participants' environments. Together, these tools provided a holistic view of the factors contributing to visual fatigue.Each participant attended a 30-minute session during which they completed the survey and underwent a brief observational assessment. Sessions were conducted in controlled environments to ensure consistency in data collection. Participants were asked to reflect on their typical screen usage habits, preventive measures employed, and any symptoms experienced during prolonged screen time. Observational assessments recorded details such as seating posture, the alignment of screens relative to eye level, and the quality of ambient lighting. The combination of survey responses and observational data helped ensure the reliability and validity of the findings.

Data Analysis

The data collected were analyzed using statistical software SPSS v10. Descriptive statistics, such as mean, median, and standard deviation, summarized demographic and screen usage data. Inferential statistical methods, including Pearson's correlation and regression analysis, were used to examine the relationships between screen usage habits and visual fatigue severity.

RESULTS

Data were collected from 185 participants, with a higher proportion of females (55%) compared to males (45%). The majority of participants (40%) were aged 26–35 years, followed by 30% aged 18–25 years, 20% aged 36–45 years, and 10% aged 46–55 years. Regarding occupation, 50% were professionals, 30% were students, and 20% were homemakers, reflecting a diverse sample with varied screen usage habits and environmental contexts.

Table 1: Participant Demographics

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	83	45
Female	102	55
Age Group (Years)		
18–25	56	30
26–35	74	40
36–45	37	20
46–55	18	10
Occupation		

Professionals	93	50
Students	56	30
Homemakers	36	20

The results revealed that 82% of participants experienced visual fatigue symptoms, while 18% reported no symptoms. Among those affected, 60% experienced mild to moderate symptoms, and 22% reported severe symptoms. The most commonly reported issues were eye discomfort (78%), dryness (65%), and blurred vision (50%), followed by headaches (42%) and difficulty concentrating (30%).

Table 2: Prevalence and Severity of Visual Fatigue

Category	Frequency (n)	Percentage (%)
Visual Fatigue Symptoms		
Experienced Symptoms	151	82
No Symptoms	34	18
Severity Among Symptomatic Group		
Mild to Moderate	111	60
Severe	40	22
Most Common Symptoms		
Eye Discomfort	144	78
Dryness	120	65
Blurred Vision	92	50
Headaches	78	42
Difficulty Concentrating	56	30

The study found that laptops (45%) and smartphones (30%) were the most commonly used devices, with both associated with higher average symptom scores of 3.8 on a 1–5 scale. Desktops (15%) and tablets (10%) were less frequently used and had lower average symptom scores of 2.6 and 2.4, respectively. Participants using multiple devices consecutively (50%) reported a higher average symptom score of 4.1 compared to those using a single device (3.2), indicating that device variety and consecutive usage exacerbate visual fatigue symptoms.

Table 3: Device Usage and Visual Fatigue

Device Type	Frequency (n)	Percentage (%)	Average Symptom Score (1–5)
Laptops	83	45	3.8
Smartphones	56	30	3.8
Desktops	28	15	2.6
Tablets	18	10	2.4
Usage Pattern			
Single Device	92	50	3.2
Multiple Devices	93	50	4.1

The results showed that poor lighting conditions were reported by 65% of participants, who had a higher average symptom score of 4.0, compared to 2.8 for those in adequately lit environments (35%). Similarly, improper screen positioning, reported by 55% of participants, was associated with a higher average symptom score of 4.2, while those with proper screen positioning (45%) had a lower average score of 2.7.

Table 4: Environmental Factors

Factor	Frequency (n)	Percentage (%)	Average Symptom Score (1–5)
Lighting Conditions			
Poor Lighting	120	65	4.0
Adequate Lighting	65	35	2.8
Screen Positioning			
Improper Positioning	102	55	4.2
Proper Positioning	83	45	2.7

The analysis revealed that 40% of participants were aware of the 20-20-20 rule, with an average symptom score of 2.5, compared to 3.9 among the 60% who were not aware. Similarly, 35% of participants used blue light filters, reporting a lower average symptom score of 2.8, while those not using filters (65%) had a higher score of 3.9. Participants employing multiple preventive measures (30%) experienced the lowest average symptom score of 2.2, whereas those not implementing any measures (70%) had the highest score of 4.1.

Table 5: Preventive Measures and Symptom Severity

Preventive Measure	Frequency (n)	Percentage (%)	Average Symptom Score (1–5)
Awareness of 20-20-20 Rule			
Aware	74	40	2.5
Not Aware	111	60	3.9
Practice of Blue Light Filters			
Used	65	35	2.8
Not Used	120	65	3.9
Combination of Measures			
Multiple Measures	56	30	2.2
No Measures	129	70	4.1

DISCUSSION

The findings of this study highlight the widespread prevalence of visual fatigue among individuals who engage in prolonged digital screen usage. With 82% of participants reporting symptoms of visual fatigue, the study underscores the significance of addressing this emerging public health concern in an increasingly digital world. The results reveal key associations between screen usage patterns, environmental factors, preventive measures, and the severity of visual fatigue symptoms [10].The high prevalence of visual fatigue, with 22% of participants experiencing severe symptoms, aligns with existing literature on digital eye strain. Commonly reported symptoms such as eye discomfort, dryness, blurred vision, and headaches reflect the strain imposed by prolonged screen use on the visual system. The findings are consistent with the physiological mechanisms of visual fatigue, such as reduced blink rates, accommodative stress, and exposure to high-energy blue light [11]. These results emphasize the need for increased awareness and targeted interventions to mitigate visual fatigue and improve the quality of life for screen users.The study identified device type and usage patterns as significant contributors to visual fatigue severity [12]. Laptops and smartphones, used by 75% of participants, were associated with higher symptom scores compared to desktops and tablets. This may be attributed to smaller screen sizes, closer viewing distances, and extended periods of uninterrupted use, particularly with smartphones. Participants using multiple devices consecutively reported even higher symptom severity, highlighting the cumulative impact of diverse screen interactions [13]. These findings suggest that promoting balanced screen usage and encouraging breaks between device transitions could reduce visual fatigue.Environmental conditions, such as lighting and screen positioning, were strongly associated with symptom severity [14]. Poor lighting conditions, reported by 65% of participants, led to significantly higher symptom scores, likely due to increased contrast and glare. Similarly, improper screen positioning correlated with greater discomfort and strain, underscoring the importance of ergonomic adjustments. These findings reinforce the role of workplace and home environment design in reducing the risk of visual fatigue.The results indicate that awareness and implementation of preventive strategies, such as the 20-20-20 rule and blue light filters, significantly mitigate visual fatigue symptoms [15]. Participants who practiced these measures reported lower symptom severity, with the most substantial reductions observed among those adopting multiple strategies. However, only 40% of participants were aware of the 20-20-20 rule, and 35% used blue light filters, revealing a gap in knowledge and practice. These findings emphasize the need for public health campaigns and educational initiatives to promote evidence-based strategies for visual health [16].The study's findings have important implications for individuals, employers, educators, and policymakers. For individuals, adopting healthier screen habits, such as taking regular breaks, adjusting screen settings, and optimizing lighting and posture, can significantly reduce visual fatigue. Employers and educators should prioritize ergonomic workspace design and integrate visual health awareness into workplace wellness programs and school curricula [17]. Policymakers can support these efforts by promoting guidelines and regulations to safeguard visual health in digital environments [18].While this study provides valuable insights, certain limitations must be acknowledged. The reliance on self-reported data introduces the potential for recall bias, and the convenience sampling method may limit the generalizability of findings. Future research could address these limitations by employing randomized sampling and incorporating objective measures such as eye-tracking technology or tear film analysis. Longitudinal studies exploring the long-term impact of screen use on visual health and the effectiveness of preventive interventions would further enhance understanding in this field.

CONCLUSION

It is concluded that visual fatigue is a prevalent issue among digital screen users, significantly influenced by screen time, device type, environmental conditions, and preventive measures. The study highlights the importance of adopting healthier screen habits, such as ergonomic adjustments, regular breaks, and blue light filters, to mitigate symptoms. Increased awareness and targeted interventions are crucial for promoting visual health in an increasingly screen-dependent world.

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