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Cross-Sectional Study on the Prevalence of Asthenopic Symptoms Among Digital Screen Users

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ABSTRACT

Background: Eye strain (asthenopia) is a prevalent disorder in digital screen users, associated with symptoms, i.e., headache, blurred vision, eye pain, tearing, and neck pain. It is predisposed by such factors as the prolonged use of screens, improper lighting, glare, inadequate breaks (e.g., low adherence to the 20/20/20 rule), and blue light exposure. The purpose of this cross-sectional study was to determine the prevalence and severity of asthenopic symptoms in digital screen users in Muzaffargarh, Pakistan, and to determine the risk factors. **Methods**: The study was cross-sectional research performed between June and August 2024 on 194 individuals (97 digital screen users & 97 non-digital screen users), (age 18 years and above) and a control group of non-screen users. The subjects were subjected to clinical examinations such as visual acuity, refraction, slit lamp biomicroscopy, and ocular motility. The data on symptoms were obtained through examination and self-reporting. The risk factors examined include screen time per day, environmental factors (lighting, glare), ergonomic behaviors, frequency of breaks, and habits. The chi-square test, one-way ANOVA, and descriptive tests (significance: $p < 0.05$) were applied through SPSS version 27 to statistically analyze data. **Results:** The analysis identified a higher prevalence of asthenopic symptoms in digital screen users (68%) than in non-screen-using controls (22%; $p < 0.001$). The study reported eye strain (52%), blurred vision (45%), headaches (42%), dry eyes (38%), neck/shoulder pain (35%), and difficulty focusing (30%) among digital screen users. Daily screen time was strongly correlated with the symptoms, with 80% of users who spent over 6 hours a day on screens experiencing symptoms as opposed to 45% of users with limited screen exposure ($p= 0.002$). The main risk factors significantly contributed to the symptom burden: poor lighting ($p= 0.017$), the absence of blue light filters ($p = 0.004$) were the most significant environmental factors, whereas behavioral risk factors such as infrequent breaks (75% symptomatic vs. 45% with regular breaks; $p= 0.001$), reduced blinking ($p= 0.009$), multitasking across devices ($p= 0.003$), and high caffeine consumption. Ergonomically, the wrong screen positioning and poor posture were significant contributors to neck/shoulder pain ($p = 0.003$). The prevalence of headaches (47% vs. 38%) and dry eyes (43% vs. 33%) was higher in females compared to males, but the overall prevalence of symptoms was not significantly different by gender ($p = 0.09$). **Conclusion:** Long screen time (>6 hours/day), unhealthy environmental factors (lighting, glare), ineffective ergonomics, absence of breaks, and some habits (multitasking, decreased blinking)

are the main risk factors of asthenopia in users of digital screens. Ergonomics of the workplace, frequent breaks in front of the screen, and blue light filters, as well as training of the user on strategies to reduce the symptoms, are effective in controlling asthenopia.
Keywords: Asthenopia, Blurred Vision, Digital Screen Users, Digital Eye Strain, Screen Time

INTRODUCTION

Asthenopia (eye strain) is a set of eye discomfort symptoms that arise after overstraining the eyes [1, 2]. It presents in the form of different symptoms like headache, blurred vision, double vision, eye pain, and tearing [3, 4]. The factors that affect these symptoms include lighting conditions, close work, and digital screen use [5, 6]. The nature of sensations and the location may differ with the cause of asthenopia, e.g., external symptom factors, such as burning, irritation, and dryness, are commonly related to environmental factors, i.e., glare and flickering light, whereas internal symptom factors such as ache and strain are related to accommodative and vergence stress [7, 8]. Furthermore, job stress and burnout can affect the prevalence and severity of asthenopia [9]. Digital screen users have a high rate of asthenopic symptoms, visual disturbances, and ocular discomfort. A cross-sectional survey reported that 71.6 % of computer users had asthenopic symptoms; headache was most common (35%), tearing (27.1%), and ocular discomfort or pain (26.6%) [10]. These symptoms are part of a clinical syndrome known as Digital Eye Strain (DES), which has been on the rise with the proliferation of digital devices [11].

The 20/20/20 rule (taking a 20-second break every 20 minutes to focus on something 20 feet away) is not common, and only 34% of the people in one study used this rule regularly or occasionally to prevent asthenopia [12]. Screen brightness, the absence of anti-reflection films, and long screen time are some of the factors that can worsen asthenopic symptoms [13]. The intermediate brightness of the screen produces the least visual fatigue [14]. The anti-Reflection films on the computer screens didn't decrease the blink rates and inhibited the asthenopic symptoms [15]. The primary objective of this cross-sectional case study was to determine the prevalence and severity of asthenopic (eye strain) symptoms among digital screen users in Muzaffargarh. It determined the related risk factors that included the length of time spent on the screen, environmental factors, and user habits to give information on effective preventive and management measures.

MATERIALS AND METHODS

This cross-sectional case study evaluated the prevalence of asthenopia among the digital screen users in Muzaffargarh, Pakistan, between June and August 2024. The target population included adults (18 years and above) with ≥ 1 year of screen exposure in the local workplaces and offices. Among the control group, non-screen users were included. The study excluded Strabismus, nystagmus, severe ocular/systemic diseases, and non-cooperative participants. The sample size of the study was calculated based on the formula of prevalence, i.e., n = [P× (1-P) ×Z2]/d 2, where P = estimated prevalence (0.49), Z = 1.96 (95% CI), and d = 0.10 (margin of error) [16]. The estimated sample size through this empirical calculation was 97. Therefore, the total sample size of the study was 194 individuals, divided into digital screen user n=97 and control group (non-screen user) n=97.

DATA COLLECTION PROCEDURE

For data collection, participants were subjected to thorough ophthalmic examination with standardized procedures, including functional (visual acuity, refraction, cover test, convergence, ocular motility, and pupillary response) and structural (slit lamp biomicroscopy and retinoscopy) tests. The systematic recording and comparison of the profile of symptoms with the time of screen exposure, ergonomic factors (light, distance), and the behavior of the user (the number of breaks and settings) were carried out. The non-screen user control group was subjected to identical assessment protocols to allow a comparison. The data was recorded in a Microsoft Excel sheet and transported to IBM SPSS version 28 for analysis.

STATISTICAL ANALYSIS

The analysis of data was performed in SPSS (v28.0). Symptom prevalence and demographic variables were described using descriptive statistics. Categorical data (e.g., frequency of symptoms in screen users and controls) were compared with chi-square tests. The one-way ANOVA was used to analyse continuous variables (e.g., symptom severity vs. screen time). The statistical significance was a p-value <0.05.

RESULTS

The study included 97 participants, 52% males and 48% females. The age distribution ranged from 18 to 55 years, with a mean age of 34.5 ± 10.2 years. Most participants (58%) had been using digital screens for 1-5 years, while 42% reported more than 5 years of screen usage. The demographic information of patients is shown in Table 1. Figures 1a and 1b show the screen usage durations and gender distribution, respectively.

Table 1: Demographic Characteristics of Digital Screen Users Facing Asthenopic Symptoms

Category	Percentage (%)	Number (n)
Male	52%	50
Female	48%	47
Screen Usage (1-5 years)	58%	56
Screen Usage (>5 years)	42%	41
Age in Years (Mean ± SD)	34.5 ± 10.2	

CONTROL GROUP COMPARISON

Compared to the control group (non-screen users), where only 22% reported minor eye discomfort, the digital screen users showed a significantly higher prevalence of symptoms (68%) ($p < 0.001$) (Figure 2). None of the participants in the control group reported severe symptoms such as blurred vision or neck pain, further highlighting the impact of digital screen use on asthenopic symptoms. A one-way ANOVA test revealed a statistically significant difference in the severity of asthenopic symptoms across participants with varying screen time durations ($p = 0.001$). The post-hoc analysis showed that individuals using screens for more than 8 hours daily had significantly higher symptom severity than those with shorter screen exposure ($p < 0.05$).

PREVALENCE OF ASTHENOPIC SYMPTOMS

Among the 97 digital screen users included in the study, 66 individuals, accounting for 68% of the participants, reported experiencing at least one symptom of asthenopia (Figure 2a). This high prevalence underscores the significant impact of prolonged screen usage on ocular and associated physical health. The most frequently reported symptom was eye discomfort or strain, affecting 52% of participants (n = 50). This symptom likely results from an extended focus on digital screens, which continuously demands the eye muscles, leading to fatigue. Blurred vision was reported by 45% of individuals (n = 44), indicating that sustained screen exposure might impair the eyes' ability to focus or accommodate, potentially due to dryness or overexertion of the visual system. Thirty-eight (38%) of participants (n = 37) experienced dry eyes, which may be attributed to reduced blinking rates commonly observed during screen use. This symptom is exacerbated by environmental factors such as low humidity or exposure to air conditioning in workplaces. Headaches, reported by 42% of individuals (n = 41), were another common complaint. These may stem from eye strain, poor posture, or prolonged exposure to blue light emitted by digital screens, which have been linked to visual and neurological stress. While 30% of participants (n = 29) noted difficulty focusing, a symptom that could result from continuous near-vision tasks, which can reduce the flexibility of the eye's focusing mechanism over time. Additionally, 35% of participants (n = 34) reported neck and shoulder pain, highlighting the impact of improper ergonomics during screen use, such as poor posture or inadequate workstation setups.

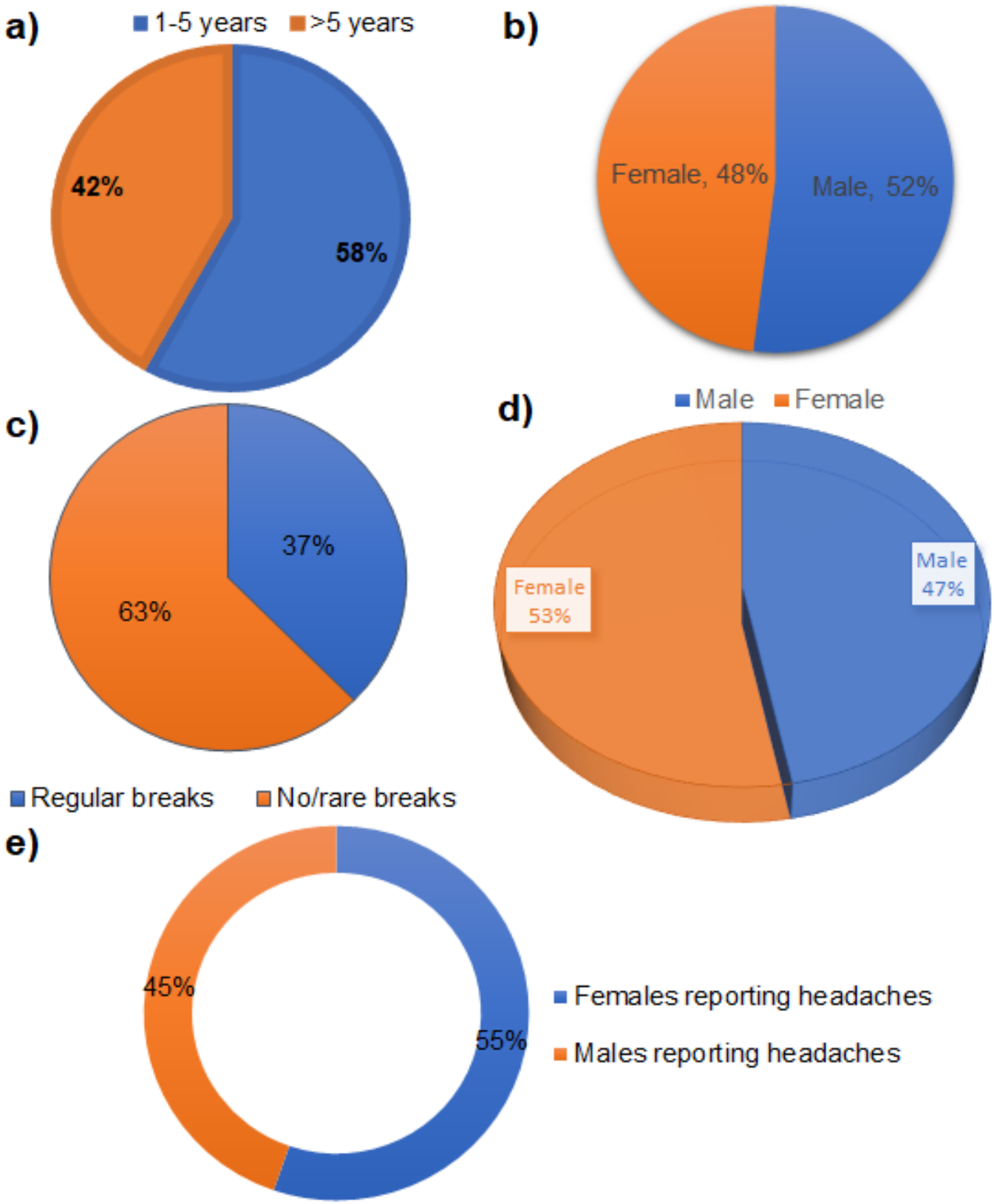

Figure 1: Pie Percentage Distribution of Prevalence of Asthenopic Symptoms among Digital Screen Users **a):** Screen usage duration per day **b):** Demographic distribution of participants **c):** Break Frequency and Asthenopic Symptoms **d):** Gender and Asthenopic Symptoms **e):** Facing severe headache

SCREEN TIME AND ASTHENOPIC SYMPTOMS

A significant positive correlation was identified between daily screen time and the prevalence of asthenopic symptoms, with a p-value of less than 0.001, indicating a highly statistically significant association (Figure 2b). Participants who used digital screens for more than six hours per day reported substantially higher discomfort and eye-related symptoms than those who spent less time on screens. Specifically, 80% of individuals in the group with screen time exceeding six hours per day experienced at least one asthenopic symptom, as opposed to only 45% of individuals with screen time under six hours per day (p = 0.002). Among participants with extended screen exposure (>6 hours/day), 65% reported experiencing pronounced eye discomfort or strain, a symptom likely linked to prolonged focusing demands and insufficient breaks during screen use. This prolonged exposure can exacerbate issues such as reduced blinking rates and increased susceptibility to blue light exposure, contributing to eye strain and dryness. Conversely, participants with shorter screen durations (<6 hours/day) exhibited fewer symptoms overall, suggesting that limiting screen time may help mitigate the onset of visual fatigue and associated discomfort.

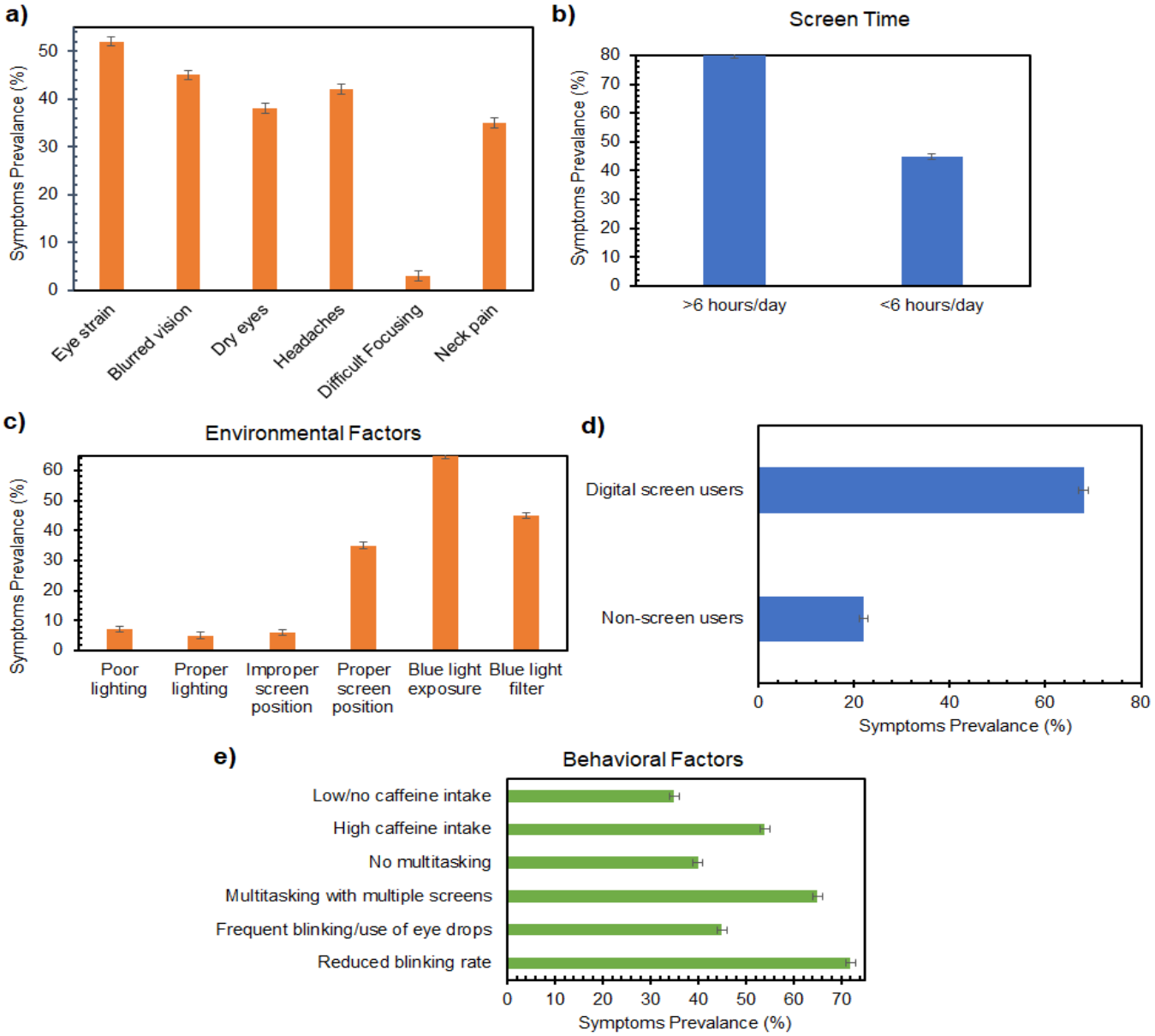

Figure 2: Bar charts showing the percentage distribution of prevalence of asthenopic symptoms among digital screen users. **a):** Prevalence of Asthenopic Symptoms **b):** Screen Time and Asthenopic Symptoms **c):** Environmental Factors and Symptoms Prevalence **d):** Comparison of control with digital screen users **e):** Behavioural Factors and Symptoms

DISCUSSION

In addition to screen time, several environmental and behavioural factors were significantly associated with the prevalence of asthenopic symptoms (Figure 2c). Lighting conditions emerged as a key determinant, with poor lighting, whether excessively bright or dim, contributing to a higher prevalence of eye strain ($p = 0.017$). Participants exposed to excessive screen glare reported a significantly higher incidence of symptoms such as dry eyes and blurred vision, affecting 68% of these individuals. In contrast, those working in properly lit environments or utilizing anti-glare filters experienced a lower prevalence of these symptoms (47%). Proper lighting and glare management thus appear essential in mitigating visual discomfort [17]. Screen positioning also played a crucial role in symptom development. Incorrect positioning, such as placing screens too close or too far from the eyes, was linked to increased eye strain and blurred vision. Improper screen height, particularly when not aligned with eye level, contributed to a notable rise in neck and shoulder pain ($p = 0.01$). This finding highlights the importance of adjusting screen height and distance to maintain a natural viewing angle and reduce strain on the eyes and the musculoskeletal system [18, 19].

Exposure to blue light was another significant factor influencing symptom prevalence. Participants who used screens without blue light filters reported higher rates of headaches (54%) and difficulty focusing (40%) compared to those who employed blue light-reducing glasses or filters ($p = 0.004$). Blue light exposure has been shown to disrupt visual and neurological processes, exacerbating discomfort and fatigue, further emphasizing the need for protective measures against its harmful effects. The frequency of breaks during screen uses profoundly impacted symptom management. Participants who took regular breaks, defined as at least one break every hour, reported a markedly lower prevalence of symptoms (45%) compared to those who worked continuously for extended periods without breaks (75%) ($p = 0.001$). The lack of screen breaks was particularly associated with a significant increase in headaches and eye strain, suggesting that periodic pauses are essential for alleviating visual and mental fatigue (Figure 1c). Lastly, ergonomics significantly influenced symptom prevalence. Poor posture, such as slouching or using an improperly adjusted chair, correlated with a higher incidence of neck and shoulder pain ($p = 0.003$). Conversely, participants who worked at ergonomic workstations reported significantly fewer symptoms, highlighting the importance of optimal seating, desk height, and screen alignment to minimize discomfort [18, 20].

The current study identifies behavioural factors that affect asthenopic symptoms is very consistent with some of the latest studies, and this provides a good background for the interpretation of these findings. One of the most important findings, the relationship between slower blinking rate when using a digital device and a higher prevalence of dry eye symptoms, replicates a prospective study in children, which showed that one hour of smartphone gaming reduced the blink rate (20.8 to 8.9 blinks/min, $p<0.001$) and significantly exacerbated dry eye symptoms, even though there was no measurable change in tear film after this brief period [21]. On the same note, deep learning-based and clinical evaluations of blinking also indicate that reduced blink frequency and increased percentage of incomplete blinks are reliably present in patients with dry eye disease and are highly related to subjective symptom severity. This evidence highlights the essential role of blink dynamics, rate, and completeness in ocular surface health and management of digital eye strain. The interventional studies and reviews indicate that educational tools and conscious attempts to raise the rate of blinking, or the application of lubricating eye drops, can be effective in reducing symptoms among the users of digital devices [21, 22].

A slightly higher prevalence of asthenopic symptoms was observed among female participants (72%) compared to their male counterparts (64%) (Figure 1d). However, this difference did not reach statistical significance ($p = 0.09$), suggesting that while there may be a trend toward greater susceptibility in females, the variation could be attributed to chance. Despite the lack of statistical significance in overall symptom prevalence, notable gender-specific trends were observed for individual symptoms. Females reported experiencing headaches more frequently than males, with 47% of female participants affected compared to 38% of males (Figure 1e). This disparity may be related to hormonal influences, as fluctuations in hormones like oestrogen and progesterone are known to contribute to headaches, particularly migraines, in women. Additionally, lifestyle differences, such as multitasking tendencies or differences in screen use patterns, may also contribute to this increased prevalence [23, 24].

Similarly, dry eyes were more commonly reported by females, affecting 43% compared to 33% of males. This difference could stem from physiological and environmental factors. For instance, studies suggest that women may be more prone to dry eye syndrome due to hormonal differences that influence tear production, particularly during phases such as menopause or due to

the use of hormonal contraceptives [25]. Moreover, gendered behaviours such as the use of cosmetics or exposure to air-conditioned environments may exacerbate ocular surface dryness in women. The findings highlight the complex nature of asthenopic symptoms among digital screen users, with ocular and musculoskeletal issues contributing to discomfort and reduced productivity [26]. To alleviate these symptoms, the data emphasizes the importance of addressing environmental and behavioural factors, such as screen time duration, ergonomic practices, screen breaks, and eye health interventions. Additionally, promoting healthier screen usage habits, including adequate blinking, reducing multitasking, and moderating caffeine consumption, can significantly reduce the burden of these symptoms. The study also suggests the need for further research into gender-specific factors that may influence the severity and prevalence of asthenopia, which could help tailor more effective interventions.

LIMITATIONS AND RECOMMENDATIONS

This study is limited by the cross-sectional nature of the study that limits causal inference and by the single-centre sampling (Muzaffargarh), which impacts generalizability. There is a possibility of a recall bias with the use of self-reported symptoms, and the omission of psychological factors (e.g., job stress) does not overlook the critical modulators, as modern literature has found. Future studies must: use longitudinal study designs to monitor symptom development and causal mechanisms; increase multi-site sampling to a greater variety of socioeconomic regions; combine validated psychometric instruments (e.g., CVS-Q questionnaire) with objective biomarkers (blink rate sensors, tear film stability tests).

CONCLUSION

The study identifies a significant correlation between prolonged screen use, environmental conditions, behavioural factors, and the prevalence of asthenopic symptoms among digital screen users in Muzaffargarh. Increased screen time, inadequate lighting, improper ergonomics, blue light exposure, lack of breaks, and specific behavioural habits such as multitasking and reduced blinking were identified as key contributors to the higher prevalence of asthenopic symptoms. These findings underscore the need for comprehensive interventions, including workplace ergonomics, regular breaks, and reducing blue light exposure to mitigate the impact of digital screen use on eye health.

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