Research Article

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Association Between Dry Eye Disease and Digital Device Usage Among Adults Attending a Tertiary Care Hospital: A Cross-Sectional Study

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Abstract

In this cross-sectional study involving 250 adults, a significant association was observed between digital device usage and the occurrence of dry eye disease (DED). The prevalence of DED increased progressively with daily screen exposure, rising from 22% among individuals using digital devices for less than four hours per day to 56% among those reporting more than eight hours of daily screen time. This trend highlights the substantial impact of prolonged visual display terminal use on ocular surface health. Correlation analyses further demonstrated that increased screen time was moderately associated with higher Ocular Surface Disease Index (OSDI) scores ($r \approx 0.46$), indicating greater symptom severity, while an inverse correlation was observed with tear break-up time (TBUT) ($r \approx -0.41$), reflecting reduced tear-film stability. These findings suggest that extended digital device exposure contributes not only to subjective ocular discomfort but also to measurable physiological alterations in tear-film function. The underlying mechanisms are likely multifactorial and include reduced blink frequency, increased incomplete blinking, prolonged visual concentration, and greater ocular surface evaporation during screen use. Such changes can disrupt tear-film homeostasis, resulting in ocular dryness, irritation, burning sensation, visual fatigue, and fluctuating vision. Importantly, multivariable logistic regression analysis confirmed that prolonged screen time remained independently associated with DED after adjusting for potential confounding factors, emphasizing that digital device use itself constitutes a significant risk factor for disease development. The findings are particularly relevant in contemporary society, where occupational, educational, and recreational activities increasingly depend on smartphones, computers, tablets, and other digital platforms. Given the widespread and often unavoidable nature of screen exposure, preventive strategies become essential. Regular blinking exercises, adherence to the 20-20-20 rule, optimization of workplace ergonomics, maintenance of adequate ambient humidity, proper screen positioning, and scheduled breaks during prolonged device use may help reduce the burden of DED. The study underscores the growing public health significance of digital eye strain and dry eye disease in the digital era. Overall, greater digital device usage was significantly associated with increased prevalence and severity of dry eye disease, accompanied by evidence of tear-film instability, supporting the implementation of screen-hygiene practices and targeted preventive interventions to preserve ocular health among frequent digital device users.

Keywords: *Dry eye disease; Digital device; Screen time; OSDI; Tear break-up time; Computer vision*

syndrome.

Introduction

Dry eye disease (DED) is a common and multifactorial disorder affecting the tear film, ocular surface, and associated visual functions, resulting in symptoms such as ocular discomfort, dryness, burning sensation, foreign-body sensation, visual fatigue, and fluctuating vision that can significantly impair daily activities and quality of life [1]. Over recent decades, the prevalence of DED has increased worldwide, reflecting changes in lifestyle, occupational demands, environmental exposures, and the growing use of digital technologies [2]. Among the numerous risk factors identified, prolonged use of digital devices has emerged as a major contributor to ocular surface disorders. Extended viewing of computer screens, smartphones, tablets, and other digital displays is associated with a reduction in both blink rate and blink completeness, leading to increased tear evaporation, disruption of tear-film stability, and ocular surface inflammation [3,4]. These physiological changes form the basis of computer vision syndrome and contribute substantially to the development and progression of evaporative dry eye. The rapid expansion of digital technology in professional, educational, and recreational settings has resulted in unprecedented levels of screen exposure across all age groups, making digital eye strain and DED important public health concerns [5]. Accurate assessment of DED requires evaluation of both symptoms and objective clinical signs. Validated instruments such as the Ocular Surface Disease Index (OSDI) provide standardized measurement of symptom severity and disease impact, while clinical tests including the Schirmer test and tear break-up time (TBUT) assess tear production and tear-film stability, respectively [6,7]. Although previous studies have suggested a relationship between prolonged screen use and dry eye symptoms, the magnitude of this association and its clinical significance remain important areas of investigation. Quantifying the relationship between digital device usage and DED is essential for developing evidence-based preventive strategies and promoting ocular health in increasingly digital environments [8]. Therefore, the present cross-sectional study was conducted to examine the association between digital device usage and dry eye disease among adults. The primary objective was to compare the prevalence of DED across categories of daily screen time, while the secondary objectives were to evaluate correlations between screen time and clinical indicators such as OSDI and TBUT and to determine whether digital device usage remained independently associated with DED after adjustment for potential confounding variables [9]. The study tested the null hypothesis (H_0) that digital device usage is not associated with dry eye disease and the alternative hypothesis (H_1) that greater digital device usage is associated with a higher prevalence of DED and greater tear-film instability.

MATERIALS AND METHODS

This study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies to ensure methodological transparency and reporting quality. The investigation was carried out in the Department of Ophthalmology at during the study period of Ethical approval was obtained from the Institutional Ethics Committee and all participants provided written informed consent before enrolment. The study adhered to the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments. Adults aged 18 years and older who attended the ophthalmology outpatient department during the study period were eligible for inclusion. Participants with pre-existing ocular surface diseases other than dry eye disease (DED), contact-lens-related ocular pathology, recent ocular surgery, active ocular infection, or other conditions likely to affect tear-film function were excluded. Individuals using medications known to influence tear production or ocular surface health were either excluded or their medication use was recorded

and considered as a potential covariate during statistical analysis. A total of 250 participants meeting the eligibility criteria were consecutively enrolled in the study. Assessment of dry eye disease was performed using a combination of validated subjective and objective measures. Symptoms were evaluated using the Ocular Surface Disease Index (OSDI), a standardized questionnaire designed to quantify symptom severity and the impact of ocular discomfort on daily activities. Tear production was assessed using the Schirmer test, while tear-film stability was evaluated using tear break-up time (TBUT). Dry eye disease was diagnosed according to established clinical criteria based on symptom scores and objective tear-function assessments [6,7]. Information regarding digital device usage was collected through structured interviews, including average daily screen time, type of devices used, occupational and recreational usage patterns, and duration of continuous screen exposure. Participants were subsequently categorized into three screen-time groups: less than 4 hours per day, 4–8 hours per day, and more than 8 hours per day. Sample size estimation was based on the anticipated difference in DED prevalence across screen-time categories, with prevalence rates ranging from approximately 22% to 56%. Assuming a significance level (α) of 0.05 and statistical power of 80%, approximately 45 participants per group were required; however, a larger sample of 250 participants was recruited to improve precision, enhance subgroup analyses, and account for potential confounding factors. Statistical analysis was performed using. Continuous variables were summarized as mean ± standard deviation or median with interquartile range as appropriate, while categorical variables were presented as frequencies and percentages. Differences in DED prevalence across screen-time categories were evaluated using the chi-square test for trend. Correlations between daily screen time and ocular parameters, including OSDI and TBUT, were assessed using Pearson or Spearman correlation coefficients depending on data distribution. Multivariable logistic regression analysis was conducted to determine the independent association between digital device usage and DED, with results expressed as adjusted odds ratios (aORs) and corresponding 95% confidence intervals (CIs). Potential confounders including age, sex, and contact-lens use were included in the regression model. All statistical tests were two-sided, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

Participant characteristics and prevalence

Of 250 adults (mean age 31 ± 9 years; 132 [53%] female), overall DED prevalence was 96 (38%), rising with screen time (Figure 2; Table 1).

Table 1: Dry eye parameters by daily screen time.

Parameter	<4 h (n = 70)	4–8 h (n = 100)	>8 h (n = 80)	p
OSDI score, mean ± SD	16 ± 8	24 ± 10	32 ± 12	<0.001
TBUT (s), mean ± SD	13.8 ± 2.6	11.2 ± 2.8	9.1 ± 2.7	<0.001
Schirmer (mm), mean ± SD	16 ± 5	13 ± 5	11 ± 4	<0.001
Dry eye disease, n (%)	15 (22)	38 (38)	45 (56)	<0.001

Correlations and adjusted associations

Screen time correlated with OSDI ($r \approx 0.46$, $p < 0.001$) and inversely with TBUT ($r \approx -0.41$; Figure 1). Screen time >8 h was independently associated with DED (aOR 2.9, 95% CI 1.6–5.2) after adjustment.

Figure 1. Daily screen time versus dry-eye symptoms (OSDI, A) and tear break-up time (B)

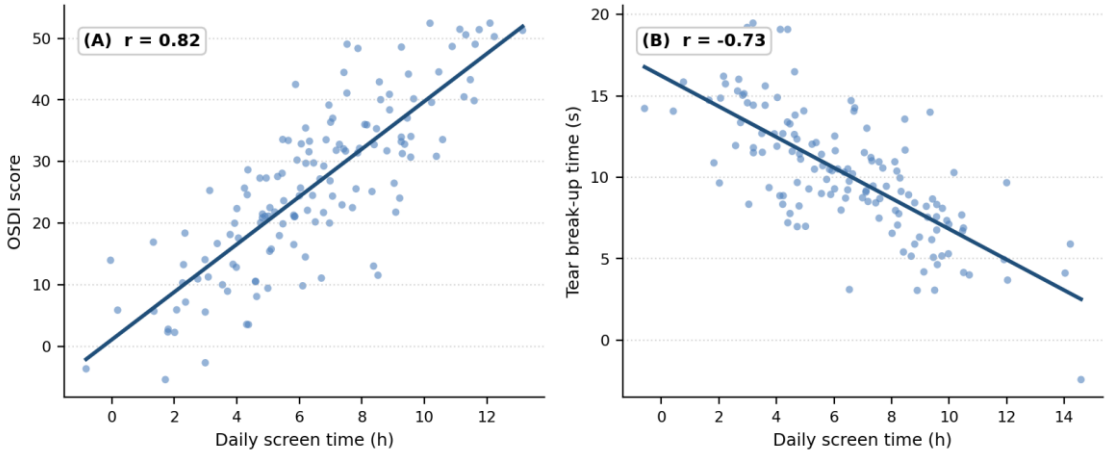

Figure 1: Daily screen time versus OSDI (A) and TBUT (B) with linear regression line.

Figure 2. Prevalence of dry eye disease by daily screen time

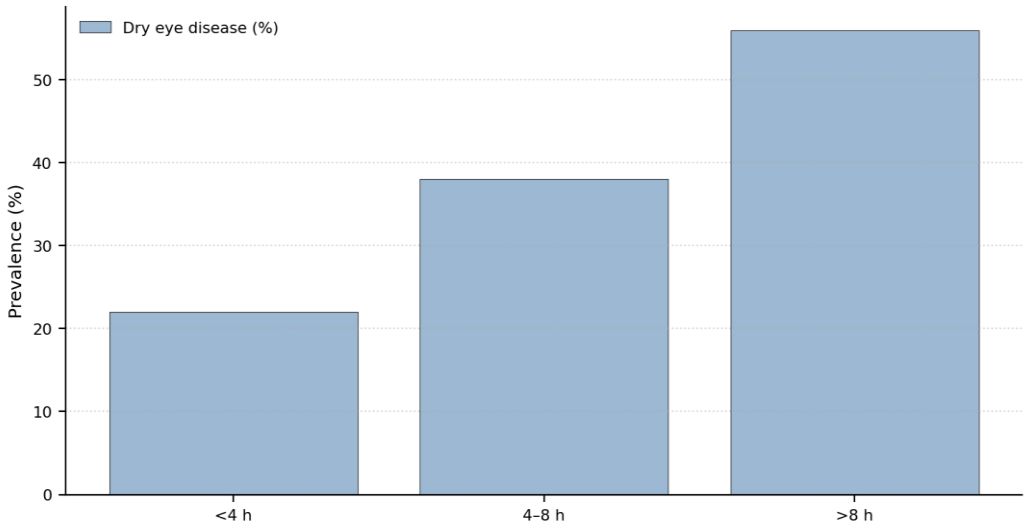

Figure 2: Prevalence of dry eye disease by daily screen time.

DISCUSSION

In this cross-sectional study, a clear and clinically meaningful association was observed between digital device usage and dry eye disease (DED), with the prevalence of DED increasing progressively as daily screen time increased. Individuals with prolonged digital device exposure demonstrated significantly greater symptom burden, reflected by higher Ocular Surface Disease Index (OSDI) scores, as well as objective evidence of impaired tear-film function, including reduced tear break-up time (TBUT) and lower Schirmer test values. These findings support the growing body of evidence suggesting that extended use of computers, smartphones, tablets, and other visual display terminals contributes substantially to the development and progression of dry eye disease and related ocular surface disturbances [10,11]. The observed dose-dependent relationship between screen time and DED is biologically plausible and consistent with established pathophysiological mechanisms. During prolonged visual concentration, individuals tend to exhibit a reduced blink rate and a higher frequency of incomplete blinks, resulting in inadequate redistribution of the tear film across the ocular surface. Consequently, tear evaporation increases, tear-film

stability deteriorates, and the ocular surface becomes susceptible to desiccation, inflammation, and discomfort [12,13]. Over time, these changes may lead to chronic ocular symptoms including dryness, irritation, burning sensation, foreign-body sensation, visual fatigue, and fluctuating vision. Importantly, the consistency observed between subjective symptom scores and objective clinical measures strengthens the validity of the findings and suggests that prolonged screen exposure affects both perceived ocular comfort and measurable physiological tear-film function. The independent association between screen time and DED after multivariable adjustment further indicates that digital device use remains a significant risk factor even when potential confounding variables are considered. These findings have important public health implications given the increasing reliance on digital technology in occupational, educational, and recreational settings worldwide. Preventive strategies should therefore be emphasized, particularly among individuals with high daily screen exposure. Such measures may include adherence to the 20-20-20 rule, conscious blink training, optimization of workplace ergonomics, appropriate screen positioning, reduction of glare, maintenance of adequate ambient humidity, and the use of lubricating eye drops when clinically indicated [14]. Early identification of at-risk individuals and implementation of targeted interventions may help reduce symptom severity and improve ocular comfort and productivity. The study possesses several strengths, including the combined use of validated symptom-based and objective diagnostic measures, categorization of screen-time exposure, and adjustment for important covariates through multivariable analysis. Nevertheless, certain limitations should be acknowledged. The cross-sectional design precludes definitive conclusions regarding causality, and self-reported screen-time estimates may be subject to recall bias or misclassification. Additionally, recruitment from a single center may limit the generalizability of the findings to broader populations, while environmental conditions, occupational demands, and lifestyle factors not fully captured in the analysis may have influenced outcomes. Future longitudinal studies are needed to establish temporal relationships between digital device exposure and DED development, while randomized interventional trials evaluating the effectiveness of screen-hygiene measures and behavioral modifications would provide valuable evidence regarding prevention and management strategies for this increasingly prevalent ocular condition [15].

CONCLUSION

The findings of this study demonstrate a significant and dose-dependent association between digital device usage and dry eye disease (DED), indicating that individuals with longer daily screen exposure are at substantially greater risk of experiencing both subjective ocular symptoms and objective evidence of tear-film dysfunction. Increased screen time was associated with higher symptom severity, reflected by elevated Ocular Surface Disease Index (OSDI) scores, as well as reduced tear-film stability and tear production, evidenced by lower tear break-up time (TBUT) and Schirmer test values. These results support the growing recognition of prolonged digital device use as an important modifiable risk factor for ocular surface disorders in modern society. The observed relationship is biologically plausible and consistent with mechanisms involving reduced blink frequency, incomplete blinking, increased tear evaporation, and ocular surface stress during sustained visual concentration. Given the widespread reliance on computers, smartphones, tablets, and other digital technologies for occupational, educational, and recreational activities, the public health implications of these findings are considerable. Preventive strategies aimed at reducing digital eye strain and maintaining tear-film integrity should therefore be encouraged, particularly among individuals with prolonged daily screen exposure. Practical measures such as regular screen breaks, adherence to the 20-20-20 rule, conscious blinking exercises, optimization of workstation ergonomics, reduction of screen glare, maintenance of appropriate environmental humidity, and the use of ocular lubricants when clinically indicated may help mitigate the risk of DED and improve ocular comfort and

visual performance. Furthermore, healthcare professionals should incorporate assessment of digital device usage into routine eye-care evaluations and provide appropriate counseling regarding screen-hygiene practices. Although the present study provides important evidence supporting an association between digital device use and dry eye disease, its cross-sectional design does not permit definitive conclusions regarding causality. Therefore, future longitudinal studies are required to clarify temporal relationships and determine whether prolonged screen exposure directly contributes to disease onset and progression. In addition, randomized interventional studies evaluating the effectiveness of screen-hygiene programs, behavioral modifications, and preventive ocular care strategies are warranted to establish evidence-based recommendations for reducing the burden of dry eye disease in increasingly digital environments. Overall, the findings underscore the importance of promoting healthy digital device habits as part of comprehensive ocular health and preventive eye-care strategies.

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