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Original Research Article

Study on Effect of Digital Screen Time on Tear Film Stability And Symptoms of Dry Eye in Young Adults

Kavuri Deepika[1], Ravi Naini Kosti[2], Ushaswi G.[3]

[1]Assistant Professor, Department of Ophthalmology, Government Medical College, Bhadradri Kothagudem

[2]Assistant Professor, Department of Ophthalmology, Gitam Institute of Medical Sciences, Visakhapatnam

[3]Assistant Professor, Department of Ophthalmology, Prathima Relief Institution of Medical College (PRIMS), Hanumakonda

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Corresponding Author: Dr. Ushaswi G

Conflict of interest: Nil

Abstract:

Introduction: Prolonged digital screen use is increasingly linked to dry eye disease in young adults due to reduced blink rate and tear film instability. Studies show longer screen time correlates with lower TBUT, Schirmer's scores, and higher OSDI scores. This study prospectively assesses screen time's impact on tear film and symptoms.

Methods: This six-month prospective study conducted at Prathima Relief Institution of Medical College and Gitam Institute of Medical Sciences included adults aged 18–35 using digital screens ≥4 hours/day. Participants were grouped by screen time and assessed at baseline, 3, and 6 months using Schirmer's test, TBUT, and OSDI questionnaire to evaluate changes in tear film and dry eye symptoms.

Results: Among 92 participants, group C (>8 hrs screen time) showed the lowest TBUT and Schirmer's values and highest OSDI scores, indicating worse dry eye symptoms. Parameters declined over 6 months, especially in group C. Strong correlations were found, negative with TBUT and Schirmer's, positive with OSDI ($P < 0.001$).

Conclusion: This study found that increased digital screen time significantly worsened tear film stability and dry eye symptoms in young adults. Longer screen use correlated with lower TBUT and Schirmer's values and higher OSDI scores. Limitations include self-reported screen time, lack of environmental control, and short follow-up duration.

Keywords: Digital Screen Time, Dry Eye Disease, Schirmer's test, Tear Break-Up Time (TBUT), Ocular Surface Disease Index (OSDI).

Introduction

The widespread use of digital devices such as smartphones, laptops, and tablets has significantly increased among young adults in recent years. Prolonged screen exposure has been associated with various ocular complaints, particularly symptoms related to dry eye disease (DED) [1]. Digital eye strain, also referred to as computer vision syndrome, is now recognized as a public health concern, especially in younger populations with high daily screen time exposure. The reduced blink rate and increased incomplete blinking during screen use contribute to tear film instability, evaporative dry eye, and ocular surface stress [2].

Several studies have reported a direct relationship between screen time duration and both objective and subjective indicators of dry eye, including decreased tear break-up time (TBUT), reduced Schirmer's scores, and higher ocular surface disease index (OSDI) scores [3]. Moreover, tear film instability in these individuals may progress silently, making early detection and behavioral interventions crucial [4]. This study aims to prospectively evaluate the impact of digital screen time on tear film parameters and dry eye symptoms in healthy young adults.

Methods

It was a prospective observational study was conducted in the department of Ophthalmology, Prathima Relief Institution of Medical College, Hanumakonda and Gitam Institute of Medical Sciences, Vishakhapatnam. Study was conducted over a period of six months, from October 2024 to March 2025. Study protocol was approved by the institutional ethics committee. An informed written consent was taken from the study members.

The inclusion criteria for the study consisted of young adults aged between 18 and 35 years who reported using digital screens, such as smartphones,

computers, or tablets, for a minimum of four hours per day. Only those with no prior history of ocular surface diseases, including dry eye syndrome, allergic conjunctivitis, or other chronic ocular conditions, were considered eligible for participation. Participants were excluded from the study if they had a history of contact lens use or previous ocular surgery. Individuals with systemic diseases known to affect tear production, such as Sjogren's syndrome or diabetes mellitus, were also excluded. Additionally, those who had used topical ocular medications within the past three months were not eligible.

Participants enrolled in the study were categorized into three groups based on their self-reported average daily digital screen time. Group A included individuals who used screens for 4 to 6 hours per day, group B included those with 6 to 8 hours of screen time, and group C comprised participants with more than 8 hours of daily exposure. This stratification allowed for the comparative assessment of ocular surface parameters across varying durations of screen use. All participants underwent a detailed baseline ophthalmologic evaluation followed by two subsequent follow-up assessments at 3 and 6 months. Each evaluation included the Schirmer's I test, used to measure basic tear secretion, and the TBUT test to assess tear film stability and detect early signs of dry eye. Additionally, subjective symptoms of DED were evaluated using the OSDI questionnaire, a validated tool that quantifies the severity of dry eye symptoms based on patient-reported discomfort, visual disturbances, and environmental triggers. This structured assessment protocol enabled the longitudinal monitoring of both objective clinical signs and subjective symptom progression in relation to digital screen exposure, thereby offering insights into the impact of screen time on ocular surface health in young adults.

Sample size calculation: The sample size for this study was determined based on prior research examining the relationship between digital screen time and dry eye parameters such as Schirmer's test, TBUT, and OSDI scores. Assuming a medium effect size (Cohen's f = 0.25), a significance level of 0.05, and a power of 80%, the estimated minimum sample size required for comparing means across three groups using one-way ANOVA was 84. To compensate for an anticipated 10% dropout or loss to follow-up over the study period, the final sample size was increased to 92 participants.

Statistical analysis: Data were analyzed using SPSS version 22. Continuous variables were presented as mean ± SD. ANOVA was used to compare tear film parameters between groups. Pearson correlation was applied to assess the relationship between screen time and OSDI scores. P <0.05 was considered statistically significant.

Results

Of the 92 participants, there were 30 members group A, 31 each in group B and C, respectively. The mean age across the groups was comparable (group A: 24.6 ± 3.1 years; group B: 25.2 ± 3.3 years; group C: 25.8 ± 2.9 years), no statistical significance (P = 0.274). The male female ratio was 1.24 (P = 0.913). The mean daily screen time was 5.1 ± 0.6 hours, 7.0 ± 0.5 hours, and 9.2 ± 1.1 hours respectively (P < 0.001). Group A showed significantly higher mean TBUT (11.4 ± 2.2 sec), Schirmer's values (18.6 ± 3.0 mm), and lower OSDI scores (12.4 ± 5.1), indicating better tear film stability and fewer symptoms. In contrast, group C had the lowest TBUT (7.1 ± 2.3 sec), lowest Schirmer's (11.5 ± 3.3 mm), and highest OSDI score (26.3 ± 6.4), with all comparisons showing statistical significance (P < 0.001). When the longitudinal changes in tear film parameters over baseline, 3 months, and 6 months were analysed, TBUT and Schirmer's values progressively declined across all groups, with the most pronounced reduction in group C. At 6 months, TBUT dropped to 6.0 seconds and Schirmer's to 10.0 mm in group C. Statistically significant decline over time across the groups for both parameters (P < 0.001). Table 1 shows the progression of OSDI scores over time among the groups. Scores increased steadily from baseline to six months, with group C consistently reporting the highest symptom severity. The differences among groups at alltime points were statistically significant (P < 0.001). A significant negative correlation was observed with TBUT (r = –0.64) and Schirmer's test (r = –0.58), while a strong positive correlation was found with OSDI score (r = +0.71), all statistically significant (P < 0.001).

Discussion

This prospective observational study revealed a significant association between increased digital screen time and impaired tear film parameters among young adults. Of the 92 participants, those with higher screen time, particularly in group C, demonstrated markedly lower tear film stability, as evidenced by reduced TBUT and Schirmer's test values. Conversely, group A maintained better tear film metrics and reported fewer symptoms of dry eye as per OSDI scores. These findings align with previous studies that identified a strong negative impact of prolonged screen exposure on ocular surface health, primarily due to reduced blink rate and increased incomplete blinking during screen use [5, 6]. This pattern leads to increased tear evaporation and instability, predisposing individuals to evaporative DED, especially in digital device users [7].

Statistical comparisons between groups confirmed the significance of these associations (P<0.001) for TBUT, Schirmer's, and OSDI scores, supporting the hypothesis that increased screen exposure

exacerbates both objective signs and subjective symptoms of dry eye. Similar results were reported by Moon et al. in school-aged children and by Sheppard and Wolffsohn in adult computer users [8, 9]. Furthermore, our study found a strong positive correlation (r = +0.71) between screen time and OSDI scores, reinforcing that symptoms of digital eye strain worsen with longer screen use. These findings emphasize the clinical need to screen young adults with high digital screen exposure for early signs of DED, even in the absence of systemic illness or ocular surface disease [6]. Preventive strategies, such as blink training, regular screen breaks (20-20-20 rule), and use of ocular lubricants, should be considered in this population to mitigate the ocular surface damage induced by prolonged screen time.

Table 1: OSDI score progression among the study members in groups

Time Point	Group A	Group B	Group C	P value
Baseline	12.4 ± 5.1	19.6 ± 4.9	26.3 ± 6.4	<0.001
3 months	13.1 ± 5.4	21.2 ± 5.0	28.1 ± 6.5	<0.001
6 months	13.6 ± 5.7	22.3 ± 5.3	29.8 ± 6.7	<0.001

Discussion

The present study demonstrated a progressive decline in tear film parameters over a six-month follow-up among individuals with varying levels of daily digital screen time. Both TBUT and Schirmer's test values showed a statistically significant reduction over time in all groups, with the steepest decline observed in group C (>8 hours/day). At six months, TBUT had reduced to 6.0 seconds and Schirmer's to 10.0 mm in this group, reflecting clinically relevant tear film instability and aqueous tear deficiency. These changes were less pronounced in groups A and B, indicating that higher screen time contributes to worsening tear film function over time. The decline in tear metrics aligns with previous findings that prolonged digital screen exposure leads to ocular surface stress through decreased blink frequency and increased tear evaporation [5, 8].

Longitudinal studies have similarly shown that chronic screen exposure induces subclinical changes in tear production and stability, which may worsen without timely intervention [6]. The statistically significance (P < 0.001) in both TBUT and Schirmer's values over time suggests that these alterations are not transient but may persist or even progress if screen habits remain unchanged. Importantly, Uchino et al. emphasized that continuous screen exposure impairs mucin production and disrupts the tear film lipid layer, compounding dry eye symptoms [11]. These findings underscore the need for early screening, preventive measures such as regular breaks, and education on eye ergonomics to mitigate the progression of digital eye strain and dry eye disease in young screen users.

This study observed a clear and consistent increase in OSDI scores over time across all three screen time groups, with the highest progression seen in group C. OSDI scores significantly increased from baseline to 6 months in each group, suggesting a worsening of subjective dry eye symptoms associated with prolonged digital exposure. These findings align with the growing body of evidence linking digital screen use to digital eye strain and DED, especially among young adults who are increasingly reliant on electronic devices [9]. The progressive elevation in OSDI scores, even in those with moderate screen use, underscores the chronic impact of digital habits on ocular surface health [8].

In addition to the longitudinal increase in symptoms, this study also found a significant negative correlation between daily screen time and objective tear film parameters. TBUT and Schirmer's values were inversely related to screen duration, with correlation coefficients of –0.64 and –0.58, respectively. These findings are consistent with previous studies reporting that screen exposure leads to decreased blink rate, increased tear evaporation, and disruption of the tear film lipid layer [5, 12]. Reduced tear film stability contributes to both evaporative and mixed-type dry eye, further aggravating ocular discomfort and visual disturbance. In particular, it was demonstrated similar reductions in mucin secretion and tear stability among office workers using visual display terminals, reinforcing the pathophysiological mechanism observed in our study [13].

The most striking finding was the strong positive correlation (r = +0.71) between screen time and OSDI score, which highlights the significant subjective impact of screen use on eye health. OSDI is a validated tool for evaluating the functional and symptomatic burden of dry eye, and its progressive increase reflects the cumulative strain experienced by digital users. It was also observed that higher OSDI scores were strongly associated with both reduced tear volume and blink abnormalities in screen users [1, 14]. These results indicate that subjective discomfort increases with screen exposure, even in the absence of underlying ocular pathology. The findings call for awareness campaigns and preventive strategies, to reduce digital eye strain and prevent the long-term

development of DED in screen-exposed populations.

Conclusion

This study demonstrated a significant association between increased digital screen time and worsening tear film stability and dry eye symptoms among young adults. Participants with longer screen exposure had lower TBUT and Schirmer's values and higher OSDI scores, indicating both objective and subjective deterioration of ocular surface health. The findings underscore the need for early screening and preventive strategies in high-risk digital users. However, the study was limited by its reliance on self-reported screen time, lack of environmental control (e.g., humidity, lighting), and a relatively short follow-up duration, which may influence the generalizability of the results.

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