An Observational Study on the Effect of Prolonged Usage of Computer and Smart Devices on Vision in Adults

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Abstract

Background: The widespread use of digital devices has led to a rise in Computer Vision Syndrome (CVS), particularly among adults who spend extended hours in front of screens. This study investigates the ocular effects of prolonged computer and smart device usage in adults. **Methods:** A cross-sectional observational study was conducted among 115 adults aged 18–45 years at a tertiary care hospital in South India. Participants using digital devices for at least 3 hours daily were evaluated using a structured questionnaire and objective ophthalmic tests including Schirmer's test, Tear Break-Up Time (TBUT), blink rate, and the Ocular Surface Disease Index (OSDI). Data were analyzed using SPSS v26, with $p < 0.05$ considered statistically significant. **Results:** The prevalence of dry eye symptoms was 64.3%. A significant association was found between increased screen time and reduced TBUT ($p < 0.001$), lower Schirmer's scores ($p < 0.001$), decreased blink rate ($p < 0.001$), and higher OSDI scores ($p < 0.001$). Refractive errors were present in 87% of participants, with longer screen exposure linked to worsening visual discomfort. **Conclusion:** Prolonged digital device use among adults significantly affects tear film stability, blinking behavior, and ocular comfort. Early screening and preventive strategies are essential to mitigate CVS risk.

Keywords: Computer Vision Syndrome; Dry Eye; Digital Devices; Blink Rate; Ocular Surface Disease Index

Introduction

The increasing dependence on digital devices such as computers, smartphones, and tablets has fundamentally transformed modern lifestyles. With the digitization of work, education, and leisure, screen exposure has significantly increased among all age groups, especially adults. The COVID-19 pandemic further accelerated this trend as remote work and virtual communication became the norm, resulting in a marked rise in daily screen time [1]. While digital connectivity has enhanced productivity and access to information, it has also introduced a range of health concerns, with ocular issues being among the most frequently reported [2].

Prolonged screen use is known to contribute to a clinical condition termed **Computer Vision Syndrome (CVS)** or **Digital Eye Strain (DES)**. This syndrome encompasses a spectrum of visual and ocular surface complaints, including dry eyes, blurred vision, eye strain, headaches, photophobia, and gritty sensations [3]. Estimates suggest that up to 70–90% of individuals who spend more than three hours per day on digital screens report at least one CVS-related symptom [4]. The pathophysiology of CVS is multifactorial and involves a combination of reduced blink rate, increased blink interval, poor ergonomics, exposure to high-energy visible (blue) light, and altered tear film dynamics [5].

Among adults, who often engage with screens for occupational and social purposes, the burden of CVS is particularly high. Various studies have demonstrated a dose-dependent relationship between screen exposure time and the severity of dry eye symptoms and ocular surface changes [6]. Decreased tear film stability, as assessed by tear break-up time (TBUT), and reduced aqueous tear secretion, as measured by Schirmer's test, are frequently observed in individuals with prolonged screen use [7]. Moreover, alterations in blink patterns—such as a reduced blink rate and increased blink interval—further exacerbate tear film evaporation, leading to ocular discomfort and visual fatigue [8].

Refractive changes have also been associated with extended digital device use. Near work and continuous accommodation have been linked to increased incidence of myopia, particularly in populations with high daily screen engagement. Although more prevalent in adolescents, recent studies have confirmed that adults, too, experience progression of refractive errors in relation to extended near-screen activity [9].

Despite growing global awareness, there is limited region-specific evidence from semi-urban and urban Indian populations regarding the ocular impact of digital devices. Factors such as environmental conditions, occupational exposure, screen ergonomics, and access to preventive care may vary significantly, necessitating localized research. Furthermore, awareness about preventive strategies—such as the 20-20-20 rule, ergonomic adjustments, and regular blinking—is often inadequate in adult populations [10].

Given this context, the present observational study was undertaken to evaluate the ocular effects of prolonged use of computers and smart devices in adults. The study aims to quantify the severity of visual symptoms, investigate changes in blink patterns and tear film parameters, and assess the overall burden of CVS among adult users. The findings are expected to contribute to targeted interventions, improve clinical screening, and inform public health strategies aimed at reducing digital eye strain in adult populations.

Materials and Methods

This was a cross-sectional observational study conducted in the outpatient department of Ophthalmology at a tertiary care teaching hospital in South India over a period of 18 months. Adults aged 18 to 45 years with a history of using computers or smart devices for at least 3 hours per day or 18 hours per week were included. Participants with pre-existing refractive errors, congenital ocular deformities, traumatic eye injuries, or those on prolonged steroid or antibiotic therapy were excluded.

The final sample consisted of 115 eligible adults selected through consecutive sampling. After obtaining informed consent, data were collected using a structured questionnaire which recorded socio-demographic details, device usage habits, and ocular symptoms. Objective assessments included visual acuity testing (unaided and best-corrected), tear meniscus height, blink rate, blink interval, Schirmer's test, and Tear Break-Up Time (TBUT), along with anterior segment and dilated fundus examination.

Ocular symptoms were graded using the Ocular Surface Disease Index (OSDI) questionnaire. All measurements were conducted under standardized lighting conditions by a single trained examiner. Data were analyzed using SPSS version 26. Descriptive statistics were reported as means and percentages, while inferential tests including Chi-square and ANOVA were applied to assess associations, with $p < 0.05$ considered statistically significant.

Results

A one-way ANOVA revealed a significant association between the duration of device use and mean OSDI scores ($F = 10.1804$, $p < 0.001$). Participants using devices for less than 2 hours per day had the lowest mean OSDI score (11.83 ± 7.84), while those using devices for 8–10 hours recorded the highest mean score (35.23 ± 8.81), followed by the 10–12 hour group (28.27 ± 13.45). A clear dose-response relationship was observed, with symptom severity increasing proportionally with screen exposure. Table 1. There was a statistically significant difference in TBUT scores across categories of screen time duration ($F = 7.7056$, $p < 0.001$). Mean TBUT scores were highest among those with less than 2 hours of device use (10.52 ± 2.27) and progressively declined in those with longer durations, dropping to as low as 5.14 ± 1.77 in the 8–10 hour group and 6.65 ± 2.10 in the 10–12 hour group. These findings indicate deteriorating tear film stability with increased screen exposure. Table 2. The ANOVA analysis indicated a significant relationship between the amount of screen time and Schirmer's scores ($F = 5.7001$, $p < 0.001$). Participants using digital devices for less than 2 hours per day had a higher mean Schirmer's score (15.19 ± 4.05), indicating better tear production, compared to those using devices for 8–10 hours

(8.42 ± 3.35) and 10–12 hours (10.55 ± 4.59), suggesting a marked reduction in tear secretion with prolonged use. Table 3. A statistically significant association was found between screen time and blink rate (Chi-square p = 0.000). Among users with <2 hours of daily exposure, 18 (85.7%) maintained a normal blink rate (15–20 per minute), whereas only 2 individuals (9.5%) had a blink rate <10 per minute. Conversely, in the 10–12 hour group, 15 participants (75%) had a blink rate <10 per minute, and none achieved a normal rate. This clearly reflects decreased blink frequency with increasing device use duration. Table 4. A significant association was found between the duration of screen use and blink interval (Chi-square p = 0.000). Among participants using devices for less than 2 hours daily, 18 (85.7%) had a normal blink interval of 3 to 4 seconds, while only 3 (14.3%) had prolonged intervals (>10 seconds). In contrast, in the 10–12 hour use group, all 20 participants (100%) exhibited prolonged blink intervals. This trend suggests that longer exposure to digital screens leads to reduced blinking frequency and prolonged intervals, contributing to ocular surface instability. Table 5. The relationship between screen time and the presence of refractive errors was statistically significant (Chi-square p = 0.033). In the group with less than 2 hours of screen time, 7 out of 21 (33.3%) had no refractive errors. However, in all other groups with longer usage, the majority had refractive errors, with the highest proportion (95%) seen in the 10–12 hour group. These findings suggest a potential link between prolonged screen exposure and increased prevalence of visual refractive issues. Table 6. A strong statistically significant association was observed between duration of digital device usage and TMH (Chi-square p = 0.000). In the <2 hour usage group, 18 participants (85.7%) had a TMH ≥ 0.2 mm, while only 3 (14.3%) had reduced TMH (<0.2 mm). This trend reversed in longer usage groups: in the 10–12 hour group, 16 participants (80%) had TMH < 0.2 mm, indicating aqueous tear deficiency. These results support a dose-dependent reduction in tear reservoir volume with prolonged screen use.

Table 7.Multiple eye symptoms were significantly associated with longer screen time:

- **Eye discomfort** increased from 1 case (4.8%) in the <2 hour group to 9 cases (45%) in the 10–12 hour group (p = 0.000).
- **Grittiness** showed a similar pattern, rising from 1 (4.8%) in the <2 hour group to 9 (45%) in the highest exposure group (p = 0.002).
- **Painful/sore eyes** were reported by 1 (4.8%) in the shortest use group and 9 (45%) in the longest use group (p = 0.000).
- **Blurring of vision** was also significantly associated (p = 0.017), with 4 (20%) cases in the 10–12 hour group compared to only 1 (4.8%) in the <2 hour group.

These findings confirm that increased screen time contributes to higher prevalence and intensity of ocular surface symptoms. Table 8

Table 1. Duration of Device Use vs. OSDI Scores (ANOVA)

Duration of Use	n	Mean	SD
< 2 hrs	21	11.83	7.84
2 – 4 hrs	14	13.46	9.15
4 – 6 hrs	36	19.55	9.97
6 – 8 hrs	17	24.01	9.75
8 – 10 hrs	7	35.23	8.81
10 – 12 hrs	20	28.27	13.45
Total	115	20.53	12.02

ANOVA: F = 10.1804, **p < 0.001**

Table 2. Duration of Device Use vs. TBUT Scores (ANOVA)

Duration of Use	n	Mean	SD
< 2 hrs	21	10.52	2.27
2 – 4 hrs	14	9.92	2.05
4 – 6 hrs	36	9.22	3.58
6 – 8 hrs	17	7.94	2.35
8 – 10 hrs	7	5.14	1.77
10 – 12 hrs	20	6.65	2.10
Total	115	8.66	3.08

ANOVA: F = 7.7056, **p < 0.001**

Table 3. Duration of Device Use vs. Schirmer's Scores (ANOVA)

Duration of Use	n	Mean	SD
< 2 hrs	21	15.19	4.05
2 – 4 hrs	14	15.21	3.66
4 – 6 hrs	36	13.36	3.85
6 – 8 hrs	17	12.52	3.59
8 – 10 hrs	7	8.42	3.35
10 – 12 hrs	20	10.55	4.59
Total	115	13.00	4.33

ANOVA: F = 5.7001, **p < 0.001**

Table 4. Duration of Device Use vs. Blink Rate

Blink Rate (per min)	<2 hrs	2–4 hrs	4–6 hrs	6–8 hrs	8–10 hrs	10–12 hrs	Total
<10	2	4	22	12	6	15	61
10–15	1	1	3	2	1	5	13
15–20	18	9	11	3	0	0	41
Total	21	14	36	17	7	20	115

Chi-square test p = 0.000

Table 5. Duration of Device Use vs. Blink Interval

Blink Interval (sec)	<2 hrs	2–4 hrs	4–6 hrs	6–8 hrs	8–10 hrs	10–12 hrs	Total
3–4 sec	18	9	11	3	0	0	41
>10 sec	3	5	25	14	7	20	74
Total	21	14	36	17	7	20	115

Chi-square test p = 0.000

Table 6. Duration of Device Use vs. Refractive Errors

Refractive Error	<2 hrs	2–4 hrs	4–6 hrs	6–8 hrs	8–10 hrs	10–12 hrs	Total
No	7	1	3	1	2	1	15
Yes	14	13	33	16	5	19	100
Total	21	14	36	17	7	20	115

Chi-square test p = 0.033

Table 7. Duration of Device Use vs. Tear Meniscus Height (TMH)

TMH (mm)	<2 hrs	2–4 hrs	4–6 hrs	6–8 hrs	8–10 hrs	10–12 hrs	Total
<0.2 mm	3	4	22	12	7	16	64
≥0.2 mm	18	10	14	5	0	4	51
Total	21	14	36	17	7	20	115

Chi-square test p = 0.000

Table 8. Duration of Device Use vs. Eye Discomfort, Grittiness, Pain, and Blurred Vision

Symptom	<2 hrs	2–4 hrs	4–6 hrs	6–8 hrs	8–10 hrs	10–12 hrs	Total	p-value
Eye Discomfort (Yes)	1	0	3	2	4	9	19	0.000
Grittiness (Yes)	1	0	3	2	4	9	19	0.002
Painful/Sore Eyes (Yes)	1	0	3	2	4	9	19	0.000
Blurred Vision (Yes)	1	0	1	0	2	4	8	0.017

Discussion

The present study assessed the ocular effects of prolonged digital device usage among adults aged 18 to 45 years, focusing on parameters such as tear film stability, blink dynamics, refractive errors, and the presence of Computer Vision Syndrome (CVS). The findings revealed a high prevalence of dry eye symptoms and measurable clinical changes in tear film quality, particularly among those with extended screen time.

A key observation was the dose-dependent relationship between screen time and ocular discomfort. The Ocular Surface Disease Index (OSDI) scores increased significantly with longer daily use, indicating a progressive rise in subjective symptoms such as dryness, burning, and eye strain. These findings align with earlier evidence which suggests that CVS is prevalent in up to 70–80% of digital screen users, particularly in those exceeding 4–6 hours of daily use [11].

Tear film instability emerged as a prominent concern, as demonstrated by the significantly lower TBUT scores in higher usage groups. TBUT reflects the time taken for the tear film to break after a blink and is a direct measure of tear film integrity. Reduced TBUT has been strongly linked to evaporative dry eye, often triggered by infrequent blinking and poor ocular lubrication during screen use [12]. In this study, TBUT decreased from a mean of 10.52 seconds in the <2 hour group to 5.14 seconds in the 8–10 hour group, reinforcing this association.

Similarly, Schirmer's test results demonstrated reduced tear secretion with longer device use, suggesting that both evaporative and aqueous-deficient mechanisms contribute to dry eye in digital users. The decline in mean Schirmer's scores among users exceeding 8 hours daily was statistically significant and indicative of impaired lacrimal gland function or reflex secretion suppression, possibly due to prolonged attention and limited blinking [13].

Blink dynamics were notably affected by screen duration. More than 50% of participants had a blink rate below 10 blinks per minute, particularly in the higher duration groups. Additionally, over 64% exhibited blink intervals exceeding 10 seconds. These alterations are known contributors to tear film breakup and corneal surface desiccation, further compounding dry eye symptoms [14].

Refractive errors were present in 87% of the study population, with a statistically significant association observed between refractive status and screen exposure duration. Extended near work on screens is thought to increase accommodative stress and axial elongation, contributing to myopia progression, especially in younger adults. Recent data also suggest that accommodative lag and convergence insufficiency may manifest in habitual screen users, exacerbating asthenopic complaints [15].

The prevalence of ocular symptoms such as gritty sensation, eye pain, blurred vision, and excessive tearing was higher in participants with longer screen exposure. These findings are consistent with previous studies where individuals using visual display terminals for more than six hours a day experienced more pronounced ocular surface complaints [16]. Notably, symptoms were reported in the absence of overt anterior segment pathology in many cases, underscoring the importance of functional assessments such as OSDI, TBUT, and Schirmer's test.
The findings of this study support the hypothesis that CVS is not merely a transient discomfort but may have deeper physiological effects on the ocular surface when left unaddressed. Furthermore, the risk of chronic dry eye and potential permanent changes

in tear film composition and blink behavior may be underestimated in occupational settings [17].

From a public health perspective, these results underline the need for early screening and education regarding screen hygiene. Interventions such as regular blinking, following the 20-20-20 rule (taking a 20-second break every 20 minutes to look at something 20 feet away), optimizing workstation ergonomics, and using artificial tears have been shown to alleviate symptoms of digital eye strain and improve quality of life in affected individuals [18].

Environmental and behavioral factors such as low ambient humidity, air conditioning, prolonged near work, and poor posture further contribute to CVS and should be accounted for in preventive strategies. A multidisciplinary approach involving ophthalmologists, occupational health experts, and employers is essential to mitigate the rising burden of CVS, particularly in urban populations with high screen exposure [19].

Limitations of the study include its cross-sectional design, which restricts causal inference, and reliance on self-reported screen time, which may be affected by recall bias. Additionally, while this study focused on adults, it did not separately analyze potential gender-based differences in ocular response to digital strain, which have been noted in other literature [20].

Conclusion

This study demonstrates a strong association between prolonged use of digital devices and the occurrence of Computer Vision Syndrome in adults. Increasing screen time correlates significantly with higher symptom burden, reduced tear film stability, altered blink patterns, and diminished tear secretion. The findings emphasize the need for early recognition of digital eye strain and timely implementation of preventive strategies to reduce ocular morbidity. Regular eye checkups, screen ergonomics, conscious blinking, and lifestyle adjustments should be promoted in high-risk groups to preserve ocular health in the digital era.

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