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Original Research Article

CORRELATION OF SCREEN TIME WITH VISUAL FATIGUE AND REACTION TIME AMONG UNDERGRADUATE STUDENTS: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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ABSTRACT

Background: Digital devices are integral to undergraduate education, but prolonged screen exposure is associated with ocular discomfort and reduced functional performance. Evidence linking screen time, visual fatigue, and visual reaction time among Indian undergraduate students remains limited. The objective is to determine daily screen-use patterns and evaluate their correlation with visual fatigue and visual reaction time among undergraduate students.
Materials and Methods: This cross-sectional observational study included 100 undergraduate students aged 18–24 years at Government Medical College, Wanaparthy, Telangana, India, from September 2025 to February 2026. Screen-use characteristics and sleep duration were recorded using a structured schedule. Visual fatigue was assessed with a symptom-based validated questionnaire, and visual reaction time was measured using a computer-based simple reaction-time task. Group differences were analysed using one-way analysis of variance, the independent-samples t-test, and the chi-square test. Pearson correlation assessed relationships among continuous variables.
Results: The mean age was 20.3 ± 1.5 years, and the mean daily screen time was 6.7 ± 2.3 hours. Visual fatigue was present in 65.0% of participants. Mean visual fatigue scores increased from 6.8 ± 3.1 among students with less than four hours of screen time to 18.6 ± 4.8 among those exceeding eight hours. Corresponding reaction times increased from 248.6 ± 28.4 to 318.9 ± 42.1 milliseconds. Screen time correlated positively with visual fatigue score and reaction time. Students with visual fatigue had slower reactions than those without fatigue.
Conclusion: Longer daily screen exposure was associated with greater visual fatigue and prolonged visual reaction time. Structured visual breaks, improved screen-use behaviour, and adequate sleep should be promoted within undergraduate learning environments.
Keywords: Digital eye strain; Screen time; Undergraduate students; Visual fatigue; Visual reaction time; Computer vision syndrome.

INTRODUCTION

Digital screens have become central to contemporary undergraduate education. Smartphones, laptops, desktop computers, and tablets are used for lectures, electronic textbooks, academic communication, examinations, and recreation. This expanding exposure has produced concern regarding digital eye strain, also termed computer vision syndrome, which comprises ocular, visual, and extra-ocular symptoms arising during or after sustained digital-device use. Common manifestations include eye strain, dryness, burning, blurred vision, headache, and neck or shoulder discomfort. Although these symptoms are generally transient, recurrent discomfort can interfere with reading endurance, concentration, sleep, and academic efficiency.[1]

The mechanisms of visual fatigue are multifactorial. Prolonged near fixation increases accommodative and vergence demand, while reduced blink frequency and incomplete blinking destabilise the tear film. Glare, unsuitable viewing distance, poor posture, uncorrected refractive error, contact-lens use, and continuous work without breaks can intensify symptoms.[2] Current reviews also emphasise that risk is shaped by device type, duration of uninterrupted viewing, ambient illumination, font size, and individual ocular characteristics. Preventive approaches therefore focus on ergonomic correction, periodic distance viewing, conscious blinking, appropriate spectacle correction, and rational limits on continuous exposure.[3]

Undergraduate students represent a particularly exposed population because academic and recreational screen activities frequently overlap. Studies among medical and engineering students in India have reported a high burden of computer-related visual symptoms, with longer daily use and inadequate breaks emerging as important correlates.[4] Similar associations have been documented among office workers and university populations in other settings.[5,6] Recent Indian data using validated symptom instruments further indicate that digital eye strain remains common beyond the period of compulsory online learning.[7] A university-based study conducted during virtual education reported a prevalence close to 69%, supporting the continuing relevance of screen-associated ocular morbidity.[8]

Visual reaction time provides a simple functional measure of sensory processing, attention, and motor response. Fatigue, sleep restriction, distraction, and sustained cognitive demand can lengthen response latency. Despite extensive research on digital eye strain, fewer studies have examined whether increasing screen exposure is accompanied by measurable slowing of visual reaction time in undergraduate students. Evaluating symptoms and reaction performance together can provide a broader understanding of the functional implications of prolonged device use. The present study therefore aimed to describe screen-use patterns among undergraduate students, determine the prevalence and severity of visual fatigue, compare visual fatigue and reaction time across categories of daily screen exposure, and assess the correlations of screen time with visual fatigue score and visual reaction time.

MATERIALS AND METHODS

Study design and setting: A cross-sectional observational study was conducted at Government Medical College, Wanaparthy, Telangana, India, from September 2025 to February 2026. The institution provides undergraduate medical education and associated teaching-hospital services.

Study population and eligibility: Undergraduate students aged 18–24 years who used a digital screen daily and provided written informed consent were eligible. Acute ocular infection, recent ocular surgery or trauma, neurological disease, sedative use, and upper-limb conditions affecting testing were exclusion criteria. Corrected refractive errors were permitted and recorded.

Sample size and sampling: The sample size was calculated using $n = Z^2pq/d^2$. An anticipated prevalence of 50%, 95% confidence level, and 10% absolute precision produced a minimum of 96 participants, which was rounded to 100. Stratified random sampling from class lists provided representation across all academic years.

Data collection: A structured schedule recorded age, sex, academic year, corrective-lens use, sleep duration, primary device, purpose of use, uninterrupted exposure exceeding two hours, and visual-break practice. Daily screen time was the average combined exposure to smartphones, computers, laptops, and tablets during the preceding seven days.

Assessment of visual fatigue: Visual fatigue was measured using the validated Computer Vision Syndrome Questionnaire, which assesses the frequency and intensity of 16 ocular and extra-ocular symptoms.9 Item scores were recoded and summed; a total score of six or more indicated visual fatigue. Individual symptoms were also documented.

Reaction-time assessment: Visual simple reaction time was measured in a quiet room using a computer-based task based on the Deary–Liewald programme.10 Participants sat 50–60 cm from the display, used the dominant hand, and completed practice trials. They pressed a response key when the stimulus appeared. Invalid responses were discarded automatically, and mean valid-trial latency was expressed in milliseconds.[11]

Bias control and data quality: Testing occurred during daytime under similar illumination. Participants avoided caffeine and strenuous exercise for two hours and used their usual corrective lenses. The same computer, software, seating arrangement, and instructions were used throughout. Forms were checked immediately; no outcome data were missing.

Statistical analysis: Data were analysed using standard statistical software. Continuous variables were expressed as mean and standard deviation; categorical variables as frequency and percentage. One-way analysis of variance compared scores and reaction times across screen-time categories. The chi-square test assessed screen-time category versus visual-fatigue status. Welch's independent-samples t-test compared reaction time by fatigue status. Pearson correlation examined continuous relationships. A two-sided p-value <0.05 indicated statistical significance.

Ethical considerations: The Institutional Ethics Committee of Government Medical College, Wanaparthy approved the protocol. Participation was voluntary, written informed consent was obtained, and coded forms protected confidentiality. Procedures followed the Declaration of Helsinki.

RESULTS

A total of 100 undergraduate students were enrolled, and complete data were available for all participants. The mean age was 20.3 ± 1.5 years, with an age range of 18–24 years. Females constituted 54 (54.0%) participants, while 46 (46.0%) were males. Thirty-eight students used spectacles or contact lenses. More than half of the participants, 57 (57.0%), reported sleeping for less than seven hours per night [Table 1].

Table 1: Sociodemographic and baseline characteristics of the participants (N = 100)

Characteristic	Category	Frequency	Percentage
Age, years	Mean ± SD	20.3 ± 1.5	—
Sex	Male	46	46.0
	Female	54	54.0
Year of study	First year	26	26.0
	Second year	25	25.0
	Third year	25	25.0
	Fourth year	24	24.0
Corrective lens use	Yes	38	38.0
	No	62	62.0
Average sleep duration	<7 hours/day	57	57.0
	≥7 hours/day	43	43.0

The mean daily screen time was 6.7 ± 2.3 hours. Eighteen participants reported less than four hours of daily screen exposure, whereas 22 used digital screens for more than eight hours per day. Smartphones were the primary digital device among 72 (72.0%) students. Continuous screen use exceeding two hours without a break was reported by 58 (58.0%) participants, while only 22 (22.0%) followed regular visual breaks [Table 2].

Table 2: Screen-use characteristics of the participants (N = 100)

Characteristic	Category	Frequency	Percentage
Daily screen time	<4 hours	18	18.0
	4–<6 hours	31	31.0
	6–8 hours	29	29.0
	>8 hours	22	22.0
Primary digital device	Smartphone	72	72.0
	Laptop or desktop	21	21.0
	Tablet	7	7.0
Predominant purpose of screen use	Academic	34	34.0
	Recreational	18	18.0
	Mixed academic and recreational	48	48.0
Continuous screen use >2 hours	Yes	58	58.0
Regular visual breaks	Yes	22	22.0

Visual fatigue was identified in 65 (65.0%) participants based on the predefined study criterion. Eye strain was the most frequently reported symptom, occurring in 67 (67.0%) students, followed by headache in 54 (54.0%), ocular dryness in 49 (49.0%), neck or shoulder discomfort in 44 (44.0%), blurred vision in 38 (38.0%), and burning sensation in 36 (36.0%). The overall mean visual fatigue score was 13.0 ± 5.8.

The mean visual reaction time of the study population was 282.6 ± 42.1 milliseconds. A progressive increase in both visual fatigue score and reaction time was observed across increasing screen-time categories. Students with more than eight hours of daily screen exposure had the highest visual fatigue score and the slowest reaction time. The differences across the four screen-time groups were statistically significant for visual fatigue score ($F = 29.60$, $p < 0.001$) and reaction time ($F = 15.96$, $p < 0.001$) [Table 3].

Table 3: Visual fatigue and reaction time according to daily screen time

Daily screen time	Number	Visual fatigue score, mean ± SD	Visual reaction time, ms, mean ± SD
<4 hours	18	6.8 ± 3.1	248.6 ± 28.4
4–<6 hours	31	10.9 ± 4.2	268.3 ± 31.7
6–8 hours	29	14.8 ± 4.5	291.5 ± 35.9
>8 hours	22	18.6 ± 4.8	318.9 ± 42.1
Statistical value	—	F = 29.60	F = 15.96
p-value	—	<0.001	<0.001

The prevalence of visual fatigue also increased significantly with longer screen exposure. Visual fatigue was observed in 5 (27.8%) students with less than four hours of daily screen time, compared with 21 (95.5%) students who used screens for more than eight hours per day. The association between screen-time category and visual fatigue was statistically significant ($\chi^2 = 24.98$, $p < 0.001$) [Table 4].

Table 4: Association between daily screen time and visual fatigue

Daily screen time	Visual fatigue present, n (%)	Visual fatigue absent, n (%)	Total
<4 hours	5 (27.8)	13 (72.2)	18
4–<6 hours	16 (51.6)	15 (48.4)	31
6–8 hours	23 (79.3)	6 (20.7)	29
>8 hours	21 (95.5)	1 (4.5)	22
Total	65 (65.0)	35 (35.0)	100

$\chi^2 = 24.98$; $p < 0.001$.

Participants with visual fatigue demonstrated a significantly slower mean reaction time than those without visual fatigue. The mean reaction time was 299.8 ± 39.6 milliseconds among students with visual fatigue and 250.7 ± 27.8 milliseconds among those without visual fatigue ($t = 7.22$, $p < 0.001$).

Pearson correlation analysis demonstrated a strong positive correlation between daily screen time and visual fatigue score ($r = 0.62$, $p < 0.001$). Screen time was also positively correlated with visual reaction time ($r = 0.49$, $p < 0.001$), indicating that prolonged screen exposure was associated with slower responses. Visual fatigue score showed a moderate positive correlation with reaction time ($r = 0.43$, $p < 0.001$). Sleep duration was negatively correlated with visual fatigue and reaction time [Table 5].

Table 5: Correlation of screen time with visual fatigue and reaction time

Variables	Correlation coefficient (r)	p-value
Daily screen time and visual fatigue score	0.62	<0.001
Daily screen time and visual reaction time	0.49	<0.001
Visual fatigue score and visual reaction time	0.43	<0.001
Sleep duration and visual fatigue score	−0.31	0.002
Sleep duration and visual reaction time	−0.27	0.007

Overall, increasing daily screen time was significantly associated with a greater burden of visual fatigue and prolonged visual reaction time among undergraduate students.

DISCUSSION

The present study identified substantial digital exposure among undergraduate students, with a mean screen time of 6.7 hours per day and visual fatigue in 65.0% of participants. Eye strain, headache, ocular dryness, and neck or shoulder discomfort were the dominant symptoms. This pattern is consistent with the recognised combination of ocular-surface, accommodative, and musculoskeletal complaints associated with prolonged device use.[1-3] The predominance of smartphones and the low frequency of regular visual breaks indicate that compact-screen viewing and uninterrupted near work are relevant behavioural concerns in this population.

The observed prevalence was lower than the high symptom burden reported among medical and engineering students in Chennai, but it remained close to the 67.4% prevalence reported among computer office workers in Sri Lanka and the 68.5% prevalence documented among university students during virtual learning.[4,5,8] Differences between studies can reflect the diagnostic instrument, symptom threshold, academic workload, device mix, environmental conditions, and the period during which exposure was measured. Mowatt and colleagues also described frequent eye strain and neck symptoms among university students, supporting the symptom distribution observed in the present study.[6]

A clear exposure-response pattern was evident. Visual fatigue prevalence increased from 27.8% in students using screens for less than four hours to 95.5% among those exceeding eight hours. Mean symptom scores also rose steadily across screen-time categories. These findings agree with Indian university data in which prolonged digital use and deficient preventive practices were determinants of digital eye strain.[7] Studies using the validated Computer Vision Syndrome Questionnaire similarly demonstrate that cumulative exposure, optical correction, and ocular-surface factors influence symptom occurrence.[12] The present correlation coefficient of 0.62 indicates a strong linear relationship between daily exposure and fatigue severity, although the cross-sectional design does not establish temporality.

An important finding was the positive association between screen time and visual reaction time. Mean latency increased by approximately 70 milliseconds between the lowest and highest exposure categories, and students with visual fatigue responded more slowly than asymptomatic students. Reaction time reflects stimulus detection, attentional allocation, central processing, and motor execution; these components are sensitive to fatigue and reduced vigilance.[10,11] Prolonged near work can increase subjective fatigue, while discomfort and attentional distraction can reduce response efficiency. The moderate correlation between fatigue score and reaction time therefore provides functional support for the symptom findings.

Sleep duration showed negative correlations with both visual fatigue and reaction time. More than half of the participants slept for fewer than seven hours, creating a plausible coexisting source of reduced alertness. Experimental and review evidence indicates that sleep loss slows responses and increases lapses of attention.[14] Nevertheless, screen exposure retained a direct correlation with both study outcomes. The findings support practical institutional measures, including scheduled visual breaks, ergonomic education, appropriate viewing distance, correction of refractive error, and reinforcement of adequate sleep. Longitudinal studies with device-recorded exposure and repeated reaction-time testing are required to clarify directionality and evaluate intervention effects.

Limitations: The study was conducted at a single institution with a modest sample, limiting wider generalisability. Screen time and sleep duration were self-reported and were vulnerable to recall error. The cross-sectional design prevented assessment of temporal sequence or causality. Residual confounding from detailed refractive status, caffeine intake, stress, physical activity, device brightness, and ambient illumination remained possible despite standardised reaction-time testing procedures.

CONCLUSION

Undergraduate students had substantial digital exposure, and nearly two-thirds fulfilled the visual-fatigue criterion. Longer screen time showed a graded association with higher symptom scores, greater visual-fatigue prevalence, and slower visual reaction time. Students reporting visual fatigue also demonstrated significantly prolonged response latency. Shorter sleep duration correlated with both adverse outcomes. These findings indicate that screen-related discomfort extends beyond subjective ocular symptoms and is accompanied by measurable functional slowing. Medical colleges should promote regular visual breaks, suitable viewing distance, ergonomic posture, appropriate refractive correction, balanced recreational use, and adequate sleep. Prospective multicentre studies using objectively recorded screen exposure should confirm these relationships and test structured preventive interventions in diverse undergraduate populations.

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