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Association Between Digital Device use and Dry Eye Symptoms Among Students at Medical Colleges in Punjab, Pakistan

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ABSTRACT

Background: Ocular discomfort is a concern among students who regularly use digital devices. We examined the association between digital-device use and dry-eye symptoms among students attending medical colleges in Punjab, Pakistan.

Methods: This analytical cross-sectional study included 194 students recruited through non-probability consecutive sampling between 12 July and 25 October 2026. A self-administered Google Forms questionnaire assessed digital-device use, ocular health, and lifestyle characteristics. Symptoms were measured using the Ocular Surface Disease Index (OSDI). Primary symptom analyses included participants completing all 12 items. Multivariable linear regression with HC3 robust standard errors examined weekday screen-time categories, adjusting for age, sex, contact-lens use, and current ocular conditions.

Results: Median participant age was 21 years (interquartile range: 19–23). Daily screen exposure of ≥6 hours was reported by 42.3% on weekdays and 64.9% on weekends. Among 114 participants completing the OSDI, the mean score was 39.3 ± 21.2; 103 screened positive (90.4%; 95% confidence interval [CI]: 83.5%–94.5%), including 62 (54.4%) with severe symptoms. In the adjusted analysis (n=113), weekday screen-time category was not significantly associated with symptom scores overall (p=0.214). Higher scores were associated with male sex (adjusted difference: 17.42 points; 95% CI: 8.81–26.02), regular contact-lens use (16.80; 3.47–30.13), and current ocular conditions (11.67; 2.76–20.59).

Conclusion: Symptom burden was high among respondents completing the OSDI. Weekday screen duration showed no significant adjusted association with severity, although estimates were imprecise. The findings support attention to student ocular health and further investigation using clinical examinations and prospective exposure measurement.

Introduction

Digital devices are embedded in university education, supporting learning, communication, and recreation. Their widespread use has also drawn attention to ocular discomfort during sustained screen viewing. Dry eye disease involves disrupted tear-film homeostasis accompanied by ocular symptoms,[1] with tear-film instability, hyperosmolarity, inflammation, and neurosensory abnormalities contributing to its development.[2] Its effects on visual functioning and quality of life make ocular surface health relevant to students undertaking prolonged visual tasks.[3]

Screen-related symptoms require careful interpretation. Digital eye strain encompasses ocular surface complaints alongside accommodative and binocular difficulties; it is therefore not interchangeable with dry eye disease.[4–6] Changes in blinking, particularly incomplete eyelid closure, offer a plausible link between screen viewing and ocular surface exposure.[7,8] Research among visual-display users also highlights the importance of considering individual susceptibility alongside exposure duration.[9]

Screen use takes place within a wider environmental and behavioural context. Humidity and airflow may influence ocular surface comfort,[10] while sleep disturbances are associated with dry-eye symptoms.[11] Pakistani student research and international university surveys provide relevant evidence,[12,13] but cannot directly characterise students attending medical colleges across Punjab. Examining uninterrupted use, breaks, and viewing practices alongside total screen time may help identify associations relevant to student health.

The Ocular Surface Disease Index provides a standardised assessment of symptom burden,[14] although questionnaire findings must remain distinct from clinical diagnosis.[15] This study therefore examined the association between digital-device use and dry-eye symptoms among students at medical colleges in Punjab, Pakistan, accounting for selected demographic and ocular factors.

Materials and Methods

We conducted an analytical cross-sectional study among students attending medical colleges across Punjab, Pakistan, between 12 July and 25 October 2026. Using non-probability consecutive sampling, we recruited students through Google Forms links and obtained 194 responses. Students enrolled at participating colleges who provided informed consent were eligible. Participation was restricted to the target student population, and the dataset was checked for duplicate submissions.

The self-administered questionnaire collected demographic information, digital-device use, screen-viewing practices, ocular and general health characteristics, and lifestyle and environmental exposures. Digital-use measures included weekday and weekend screen time, uninterrupted screen-use duration, break frequency, practice of the 20-20-20 rule, bedtime use, viewing distance, screen position, and use in dim lighting. Other measures included spectacle and contact-lens use, lubricating eye drops, current eye infection, injury or significant allergy, previous eye surgery, systemic conditions, medication use, sleep, water intake, air-conditioning exposure, direct airflow, and academic stress.

Dry-eye symptoms during the preceding week were assessed using the 12-item Ocular Surface Disease Index (OSDI).[14] Each item was scored from 0 (“none of the time”) to 4 (“all of the time”). The total score was calculated by multiplying the sum of answered item scores by 25 and dividing by the number of items answered, yielding a score from 0 to 100. Higher scores indicated greater symptom burden. A score ≥13 defined a positive symptom screen; thresholds of 13, 23, and 33 distinguished mild, moderate, and severe symptom categories.[15] These outcomes represented self-reported symptoms rather than clinically confirmed dry-eye disease.

Categorical variables were summarised as frequencies and percentages using available-response denominators. Continuous variables were described using means and standard deviations or medians and interquartile ranges. The positive-screen proportion was reported with a Wilson 95% confidence interval. Primary symptom analyses included the 114 respondents who completed all OSDI items. An exploratory sensitivity analysis used available-item scores for respondents completing at least 10 items, including all five ocular-symptom items. This completeness threshold was selected for the present analysis rather than treated as an established OSDI requirement. Respondents with complete and incomplete OSDI questionnaires were compared on selected demographic and exposure characteristics.

Unadjusted differences in OSDI scores were examined using Kruskal–Wallis tests. Multivariable linear regression assessed associations between weekday screen-time categories and continuous OSDI scores, adjusting for age, sex, contact-lens use, and current ocular conditions. Screen exposure below two hours daily was the reference category. The adjusted analysis included 113 participants with complete information for the model variables. Adjusted differences were reported in OSDI points with HC3 heteroscedasticity-robust standard errors and 95% confidence intervals. The overall screen-time association was assessed using a joint robust Wald F-test. Regression checks assessed residual distribution, multicollinearity, leverage, and influential observations.

A sensitivity analysis excluded the observation with the largest Cook's distance. Analyses were conducted in Python using pandas 2.2.3, NumPy 2.3.5, and SciPy 1.17.0. Tests were two-sided, with $p<0.05$ considered statistically significant; secondary comparisons were interpreted as exploratory.

Results

The study included 194 students. Age was available for 190 participants, with a median of 21 years (interquartile range [IQR]: 19–23). Of the 193 participants who reported their sex, 150 (77.7%) were female. Screen use of at least six hours daily was more common on weekends than weekdays, reported by 64.9% and 42.3% of participants, respectively. Almost one-third reported uninterrupted use lasting at least two hours, whereas only eight students regularly followed the 20-20-20 rule (**Table 1**).

Table 1: Participant characteristics and selected digital-device behaviours

Characteristic	n/N (%) or median (IQR)
Age, years	21 (19–23)
Female	150/193 (77.7%)
Male	43/193 (22.3%)
Weekday screen time ≥6 hours/day	82/194 (42.3%)
Weekend screen time ≥6 hours/day	126/194 (64.9%)
Uninterrupted screen use ≥2 hours	63/194 (32.5%)
No breaks during prolonged screen use	35/194 (18.0%)
Unaware of the 20-20-20 rule	77/194 (39.7%)
Regularly followed the 20-20-20 rule	8/194 (4.1%)

Age was available for 190 participants. Percentages use the available-response denominator. IQR: interquartile range.

All 12 OSDI items were completed by 114 participants, representing 58.8% of the total sample. Their mean OSDI score was 39.3 ± 21.2, and the median was 34.4 (IQR: 25.0–50.0). Among these respondents, 103 screened positive for dry-eye symptoms (90.4%; 95% confidence interval [CI]: 83.5%–94.5%). More than half had scores within the severe symptom category (**Table 2**).

Table 2: Distribution of OSDI symptom severity among participants with complete questionnaires (n=114)

Symptom category	OSDI score	n (%)
Normal	<13	11 (9.6%)
Mild	≥13 to <23	16 (14.0%)
Moderate	≥23 to <33	25 (21.9%)
Severe	≥33	62 (54.4%)
Positive symptom screen: mild, moderate or severe	**≥13**	**103 (90.4%)**

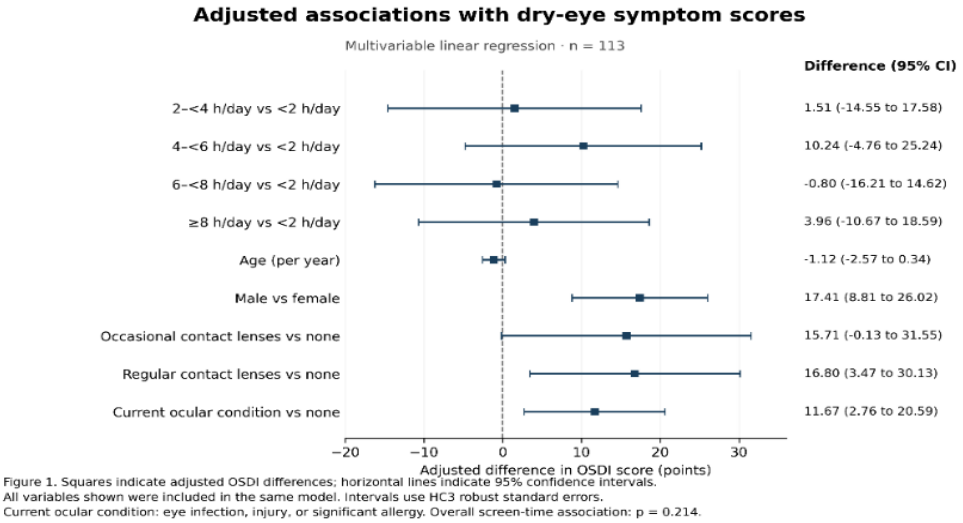
Categories were assigned using unrounded scores. The final row combines the three symptomatic categories. Percentages may not total 100% because of rounding. OSDI: Ocular Surface Disease Index.

In unadjusted comparisons, OSDI scores did not differ significantly across categories of weekday screen time ($p=0.413$), weekend screen time ($p=0.760$), uninterrupted screen use ($p=0.496$), or break frequency ($p=0.251$). Differences were observed by sex ($p=0.002$), contact-lens use ($p=0.007$), and current eye infection, injury, or significant allergy ($p=0.006$).

The adjusted regression analysis included 113 participants. Weekday screen-time category was not significantly associated with OSDI score overall (joint robust Wald F-test, $p=0.214$). Male participants had scores averaging 17.42 points higher than female participants after adjustment (95% CI: 8.81–26.02). Regular contact-lens use was associated with a 16.80-point increase compared with no use (95% CI: 3.47–30.13), while current ocular conditions were associated with an 11.67-point increase (95% CI: 2.76–20.59). The estimate for occasional contact-lens use was positive, but its confidence interval included zero. **Figure 1** presents the adjusted estimates and their uncertainty.

Figure 1. Adjusted associations with dry-eye symptom scores (n=113). Squares indicate adjusted differences in OSDI points, and horizontal lines show 95% confidence intervals calculated using HC3 robust standard errors. All displayed variables were included in the same model. The dashed vertical line represents no difference. Current ocular conditions comprise eye infection, injury, or significant allergy.

Figure 1. Adjusted associations with dry-eye symptom scores (n=113)



Respondents with complete and incomplete OSDI questionnaires did not differ significantly in age (p=0.396), sex (p=0.275), weekday screen-time category (p=0.695), contact-lens use (p=0.644), or current ocular conditions (p=0.728). In the exploratory available-item analysis, 158 participants met the specified completeness threshold; 144 (91.1%) screened positive, compared with 90.4% in the primary analysis. Excluding the observation with the greatest influence on the regression model also left the overall screen-time association non-significant (p=0.185).

Discussion

This study found a substantial burden of dry-eye symptoms among students who completed the OSDI questionnaire. Nine in ten screened positive, and more than half reported symptoms within the severe category. Despite this burden, weekday screen-time category was not significantly associated with OSDI scores after adjustment. Higher scores were associated with male sex, regular contact-lens use, and current ocular conditions. Taken together, these findings suggest that reported screen duration alone did not adequately distinguish symptom severity within our sample.

Our positive-screen proportion was higher than estimates from several comparable studies. In Pakistan, Hashmani and colleagues reported a prevalence of 64.4% among 2,433 non-clinical participants in Karachi.[16] Asiedu and colleagues found symptomatic dry eye in 44.3% of Ghanaian undergraduates, although their case definition differed from ours.[17] Among Indian medical students, Aberame and colleagues reported an OSDI-based prevalence of 46.1%, with severe symptoms in 16.1%.[18] Lulla and colleagues reported corresponding estimates of 41.5% before the pandemic and 55.19% during the pandemic using a modified OSDI questionnaire.[19] Our findings therefore indicate a particularly high symptom burden among respondents with complete questionnaires. They should not, however, be interpreted as demonstrating a higher underlying disease prevalence across Punjab, given differences in recruitment, participant characteristics, and assessment methods.

The distinction between symptoms and clinically established disease is central to these comparisons. Li and colleagues reported dry eye in approximately 10% of Shanghai University students following questionnaire assessment and ophthalmological examination.[20] Their estimate addresses a different outcome from our symptom screen. Bartlett and colleagues found inconsistent associations between dry-eye symptoms and clinical signs, while Vehof and colleagues identified patient characteristics associated with this discordance.[21,22] High OSDI scores warrant attention, but do not establish the presence or extent of ocular surface abnormalities. In our study, they represent reported discomfort and difficulty with vision-related activities rather than a confirmed clinical diagnosis.

The absence of a significant adjusted association with screen time differs from some published student research. Hyon and colleagues identified prolonged computer use as an independently associated factor among Korean medical students.[23] Lin and colleagues also found an association between visual-display exposure and symptomatic dry eye among Chinese high-school students.[24] In contrast, the detailed Chiang Mai medical-student results showed no significant difference in display-use duration between participants with and without symptoms, although contact-lens use and psychological stress were associated with the outcome.[25] Our findings add to this variation rather than resolving it. The screen-time estimates had wide confidence intervals, and relatively few participants formed the lowest-exposure reference group. Consequently, the non-significant result cannot exclude a clinically relevant association.

One possible explanation is that daily screen hours capture only part of the exposure relevant to ocular symptoms. Cardona and colleagues demonstrated changes in blinking and tear-film integrity during dynamic visual-display tasks.[26] Task demands, sustained attention, and blink completeness may therefore distinguish students with similar reported screen durations. We did not measure these processes directly. Moreover, symptomatic students may have reduced their screen use or introduced breaks before completing the questionnaire. Such reverse causation is plausible in a cross-sectional study and could weaken an observed duration–symptom relationship.

Male participants had adjusted scores approximately 17 points higher than female participants. This contrasts with the broader female predominance described in the TFOS sex, gender, and hormones report and with the Korean medical-student findings.[23,27] Our result should be interpreted cautiously: only 29 men contributed to the adjusted model, and neither hormonal influences nor detailed behavioural differences were assessed. Sampling variation, selection, and residual confounding could have contributed. The association is therefore a finding requiring replication, rather than evidence of greater male susceptibility in the wider student population.

The association with regular contact-lens use was more consistent with existing evidence. Contact-lens users had higher symptom scores in the Chiang Mai study, and Nichols and Sinnott identified tear-film, lens, and wearer characteristics associated with contact-lens-related dryness.[25,28] In our analysis, regular use was associated with an adjusted increase of 16.8 OSDI points. However, the small subgroup and wide confidence interval limit precision. Current eye infection, injury, or significant allergy was also associated with higher scores. Because these conditions can produce overlapping complaints, their association highlights the importance of assessing alternative or coexisting explanations before attributing symptoms to digital-device use.

Sleep and psychological factors also deserve consideration. Yan and colleagues reported relationships between circadian typology and dry-eye symptoms among Chinese college students, while Korean and Thai medical-student studies identified associations with psychological stress.[23,25,29] These factors were not comprehensively represented in our adjusted model and may contribute to unexplained symptom variation. Their role should be examined using validated measures in future studies.

Only eight participants regularly followed the 20-20-20 rule, suggesting limited uptake of structured visual breaks. Although reported break frequency was not significantly associated with OSDI scores, our observational comparison cannot establish whether a planned intervention would help. Talens-Estarelles and colleagues observed short-term reductions in symptoms with break reminders, without corresponding improvements in measured ocular surface signs.[30] This supports evaluating structured breaks prospectively while avoiding claims that our study demonstrated their effectiveness.

Several features strengthen the interpretation of our results, including assessment of multiple exposure domains, adjustment for relevant ocular characteristics, and sensitivity analyses. Respondents with complete and incomplete OSDI questionnaires did not differ significantly on selected measured characteristics, and available-item scoring produced a similar positive-screen proportion. Nevertheless, these checks cannot establish that missing responses were unrelated to symptom severity. The primary analysis represented 114 of 194 respondents, and non-probability recruitment further limits generalisability. Excluding the most influential regression observation left the overall screen-time finding unchanged, providing some reassurance about its stability.

The practical implication is to address student ocular symptoms without assuming that total screen hours provide a sufficient explanation. Persistent symptoms warrant clinical assessment, particularly in contact-lens users and students reporting other ocular conditions. Larger prospective studies combining objective screen-use records, validated lifestyle measures, and ocular examinations would help distinguish the contributions of exposure, susceptibility, and behaviour.

Conclusion

Dry-eye symptoms were common among students who completed the OSDI questionnaire. Weekday screen-time category was not significantly associated with symptom severity after adjustment, although the estimates were imprecise. Male sex, regular contact-lens use, and current ocular conditions were associated with higher symptom scores. These findings support attention to ocular symptoms within student health services, including contact-lens care and clinical assessment of persistent complaints. Prospective studies incorporating objective exposure measurements and ocular examinations are needed to clarify these relationships.

Limitations

The cross-sectional design prevented assessment of temporal relationships and causality. Non-probability consecutive sampling and voluntary online participation limited the representativeness of the sample. Screen use and health characteristics were self-reported, introducing potential recall and reporting errors. OSDI scores measured symptom burden without clinical confirmation of dry-eye disease. Primary symptom analyses included 114 of 194 respondents, and the adjusted analysis included 113. Although selected characteristics did not differ significantly between respondents with complete and incomplete questionnaires, selection bias could not be excluded. Small exposure subgroups, particularly the lowest screen-time category and regular contact-lens users, produced imprecise estimates. Residual confounding by sleep, psychological stress, environmental exposures, and unmeasured ocular factors remained possible.

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