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Original Research Article

Digital Display Device Usage Patterns and Their Relationship with Dry Eye Syndrome Prevalence in Medical Students

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Abstract:

Background: Rapid integration of digital display devices into medical education has increased visual strain and may contribute to Dry Eye Syndrome (DES), a condition affecting comfort, vision, and productivity among students.

Aim: To assess digital display device usage patterns and determine their relationship with the prevalence and severity of DES among medical students.

Methodology: A descriptive cross-sectional study was conducted among 300 MBBS students (18–25 years) Participants completed a structured questionnaire and Ocular Surface Disease Index (OSDI). Those with abnormal scores underwent Tear Break-Up Time, Schirmer I test, and fluorescein staining. Data were analyzed using SPSS with significance at $p<0.05$.

Results: About 75.3% of students had dry eye symptoms (mild 27.3%, moderate 25.3%, severe 22.7%). Females and students with refractive errors showed significantly higher OSDI scores ($p<0.05$). OSDI scores increased with smartphone (>5 h: 31.8±20.4) and computer (>5 h: 30.4±20.3) usage. Closer viewing distance, higher brightness, and absence of protective filters significantly worsened symptoms, while protective filters and longer viewing distance reduced severity.

Conclusion: DES is highly prevalent among medical students and strongly associated with prolonged screen time and poor ergonomic practices. Preventive education and behavioral modification are recommended.

Keywords: Dry eye syndrome, digital screen exposure, medical students, OSDI, ergonomics, visual strain.

Introduction

In the contemporary era, digital display devices, starting historically with television and increasingly followed by computers, tablet computers, and smartphones, are part and parcel of almost all areas of life. Technology are no longer used just socially and recreationally but also represent an essential element in education and professional practice. The high rate of growth of information and communication technology has seen human beings interact with digital screens more than ever across all ages, more so in developed societies [1]. It was revealed in the Global Digital 2019 Report that a majority of the global population (57 percent) depends on the internet and that there are about 4.3 billion internet users in the world (almost 1 million new daily). Furthermore, the number of people actively using social media platforms is approximately 3.5 billion (45 percent of the world population) and mobile phone ownership among people is 5.1 billion (67 percent of the world population).

Children and adolescents are no exceptions as the trend of the growing intrusion of digital technology can be observed. Research in Europe shows that children age 3 years are using computers daily (68 percent), and those age 11 (25 percent) and 17 (50 percent) years old spend daily time before screens of digital technologies (Europe) [2]. These results indicate that exposure to digital presentation devices starts in early life and is increasing during adolescence and adulthood. Screen time has therefore become an increasing issue in the public health sector particularly because of the visual and ocular health issues that have been related to it.

Digital display devices have long-term use that has been linked to a set of visual and ocular symptoms known as digital eye strain. According to the

American Optometric Association, digital eye strain is the condition that occurs due to the prolonged exposure to digital screens, which is mainly associated with the development of the dry eye syndrome (DES) [3]. DES is defined by the symptoms range, which consists of such aspects as ocular discomfort, irritation, burning sensation, blurred vision and visual fatigue. Over the past few years, it has become a significant societal health issue, with millions of people of both genders being considered to be at risk in case of such an issue due to the popularity of digital technology. A number of reports have indicated prevalence rates of DES to be up to 50 percent or more indicating that potentially a large percentage of population would need medical guidance or intervention based on the condition.

In addition to eye irritation, DES may have a huge impact on life quality. The condition has been linked to lower physical health status, poor psychological health, and low functional independence [4]. Patients often have problems with engaging in routine visual activities to read, study, and work with computers. What is more, DES is costly in terms of its economic impact. Besides direct expenses in terms of medical consultations and pharmaceutical treatment, there are indirect expenses in terms of absenteeism, reduced work productivity and reduced performance in a job of employees, which add significant weight to its effect on society. According to research, economic costs are directly proportional to the severity of the disease and the frequency of hospitalization, which highlights the need to be diagnosed early and preventive measures [5].

The effects of DES may be divided into two broad categories, in which are the symptoms associated with the eye dramatizing the dry eye and those linked to the eye as a result of visual accommodation or vergence dysfunction. The use of a digital screen is causative of these symptoms in a variety of physiological ways. Research has established that watching on a screen slows the blink rate, amplitude and completeness of the blink which destabilizes the tear film. There is also the tendency of digital reading levelling the eye, which causes the palpebral fissure to be widened and the ocular surface to expose itself more. This increased uncovered surface increases the rate of evaporating tears and worsens the ocular surface dryness.

The problem is especially topical in educational institutions, particularly in the medical ones. A major paradigm shift has been in the modern medical education that no longer relies on textbook-based learning, but students now acquire knowledge through technological means of instruction [6]. Now students in greater numbers use online portals to access lecture material, mobile applications to download notes and watch instructional video and use electronic databases as opposed to libraries to undertake research. As a result, medical students take prolonged time using laptops, tablets, and smartphones to conduct academic tasks. Besides academic screen time, they also do recreational screen time, such as social media, streaming, and gaming, which adds more cumulative screen time.

The student population in universities is a vulnerable group because of the long-duration study requirements and the lifestyles adopted by these students that involve usage of digital media. Studies have shown that stress, headaches, and migraines are more prevalent in students at universities due to the exposure to digital screens and cases of dry eyes [7]. In research carried out to examine health science students among them medical students there was high prevalence of ocular complaints reported among people who use multiple electronic devices in their daily lives [8]. In another study, it was established that high levels of psychological stress were associated with high risk of developing dry eye in medical students. These results imply that DES is multifactorial and not only screen duration, but also behavioral and psychosocial factors can have an impact on it.

A very critical group to be investigated is the medical students. Their learning task demands prolonged visual attention, long hours of study and the heavy use of digital materials. Besides, abnormal sleep patterns, elevated psychological stress and sustained almost-work activities also predispose them to ocular surface disturbances. Nevertheless, the risks still exist, and students can disregard the symptoms or postpone care, which might result in the development of mild discomfort progressing to chronic ocular disease.

Public health wise, it is important to identify and prevent the management of DES at an early stage. Primary healthcare providers and family physicians are extremely vital in preventive medicine and routine check-ups. Digital screening of ocular disorders associated with the screen could enhance detection of ocular disorders in primary care environments and lessen the effects of ocular disorders over time. Disease burden could be brought down considerably through implementation of preventive measures, including awareness campaigns, ergonomic and behavioral changes.

Given the fast-growing use of digital tools in medical education and in the routine life, it is noted that there is a necessity to reconsider the habits of their use and their impact on the vision. The awareness of trends in exposure to digital devices and their relationship with the prevalence of DES can be used to inform preventive measures, education, and screening protocols. Thus, the proposed cross-sectional study will explore how often digital display devices are used and how they are associated with the occurrence of dry eye syndrome among medical students.

Methodology

Study Design: This study was a descriptive cross-sectional observational study conducted to evaluate digital display device usage patterns and their relationship with the prevalence of Dry Eye Syndrome (DES) among medical students. The design allowed simultaneous assessment of exposure (screen usage behavior) and outcome (dry eye symptoms and clinical signs) within a defined time period.

Study Area: The study was conducted in the Department of Ophthalmology, Sri Krishna Medical College and Hospital (SKMCH), Muzaffarpur, Bihar, India.

Study Duration: The study was carried out over a period of seven months from March 2025 to September 2025.

Sample Size: The sample size was calculated using G*Power software (version 3.1.9.4). Assuming a medium effect size of 0.3, type I error of 0.05, and study power of 80%, the minimum required sample size was estimated to be 288 participants. Considering possible non-response and incomplete data, approximately 300 medical students were approached. After applying eligibility criteria and removing incomplete responses, the final number of participants included in the analysis comprised eligible consenting students.

Study Population: The study population consisted of undergraduate MBBS students studying at Sri Krishna Medical College and Hospital who voluntarily agreed to participate in the study. Participants represented different academic years to ensure variability in digital device exposure and academic workload.

Data Collection: Data collection was performed in two phases. In the first phase, participants completed a structured questionnaire that included demographic information, digital display device usage characteristics, preventive practices, and dry eye symptoms. Dry eye symptoms were assessed using the Ocular Surface Disease Index (OSDI) questionnaire. The OSDI score was calculated by multiplying the sum of responses by 25 and dividing by the number of questions answered. Scores were categorized as normal (0–12), mild (13–22), moderate (23–32), and severe (33–100).

In the second phase, participants with abnormal OSDI scores underwent detailed ophthalmic examination. Clinical tests included Tear Break-Up Time (TBUT), Schirmer I test with topical anesthesia, and fluorescein staining using the Oxford grading scale. A TBUT of less than 10 seconds and Schirmer I value less than 6 mm were considered abnormal. Diagnosis of Dry Eye Syndrome was confirmed according to TFOS DEWS II diagnostic criteria.

Inclusion Criteria

- MBBS students aged 18–25 years
- Students using digital display devices daily
- Willing to give informed consent

Exclusion Criteria

- Contact lens users
- History of ocular surgery or trauma
- Known ocular diseases (glaucoma, conjunctivitis, keratitis etc.)
- Chronic systemic illness (diabetes, autoimmune disease)
- Use of topical ocular medications
- Smokers
- Incomplete questionnaire responses

Study Procedure: Medical students were recruited through institutional communication and classroom approach. Participants who consented were asked to complete the questionnaire. OSDI scores were calculated and students suspected of having dry eye were called for ophthalmic examination. Clinical diagnostic tests were performed under aseptic precautions, and findings were recorded. All collected data were compiled and prepared for statistical analysis.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using SPSS version 20. Descriptive statistics were expressed as mean and standard deviation for continuous variables and frequency and percentage for categorical variables. Normality of numerical data was assessed using the Kolmogorov–Smirnov test. For normally distributed variables, one-way ANOVA was used, whereas non-normally distributed variables were analyzed using the Kruskal–Wallis test. Categorical variables were compared using Pearson's chi-square test, and Fisher's exact test was applied when expected cell frequencies were small. Post hoc analysis was performed using Bonferroni test for equal variance and Dunnett's T3 test for unequal variance. A p-value less than 0.05 was considered statistically significant."

Result

Table 1 presents the socio-demographic characteristics of the 300 participants (N = 300). Females constituted the majority with 204 (68%), while males were 96 (32%). The most common age group was 21–23 years (136, 45.3%), followed by 18–20 years (124, 41.3%) and 24–26 years (40, 13.4%). Most participants had no refractive error (178, 59.3%), whereas myopia was seen in 72 (24%), astigmatism in 32 (10.7%), and hypermetropia in 18 (6%). Regarding spectacle use, 126 participants (42%) used glasses while 174 (58%) did not. Overall, the sample mainly consisted of young females with predominantly normal refractive status.

Table 1: Socio-demographic characteristics of participants (N = 300)			
Variable	**Category**	**N**	**%**
Gender	Male	96	32
	Female	204	68
Age group (years)	18–20	124	41.3
	21–23	136	45.3
	24–26	40	13.4
Refractive error	None	178	59.3
	Myopia	72	24
	Hypermetropia	18	6
	Astigmatism	32	10.7
Use of glasses	Yes	126	42
	No	174	58

Table 2 shows OSDI scores according to gender and refractive status. Females had significantly higher scores (27.6 ± 19.2) than males (21.8 ± 17.4) (p = 0.018). Participants without refractive error had lower scores (22.4 ± 17.1) compared to those with myopia (29.1 ± 18.5), hypermetropia (31.3 ± 20.2), and astigmatism (28.7 ± 19.6) (p = 0.006). Those using glasses also showed higher scores (27.9 ± 18.8) than non-users (23.5 ± 18.1) (p = 0.041). Overall, female gender, refractive errors, and spectacle use were associated with greater dry eye symptoms.

Table 2: OSDI score according to gender and refractive status				
Variable	**Category**	**N**	**Mean OSDI ± SD**	**P value**
Gender	Male	96	21.8 ± 17.4	0.018*
	Female	204	27.6 ± 19.2	
Refractive error	None	178	22.4 ± 17.1	0.006*
	Myopia	72	29.1 ± 18.5	
	Hypermetropia	18	31.3 ± 20.2	
	Astigmatism	32	28.7 ± 19.6	
Use of glasses	Yes	126	27.9 ± 18.8	0.041*
	No	174	23.5 ± 18.1	

Table 3 presents OSDI scores according to daily smartphone usage time. Participants using smartphones <1 hour had a mean OSDI of 18.6 ± 15.3, those using 1–5 hours had 24.7 ± 17.9, and >5 hours had the highest score of 31.8 ± 20.4 (p = 0.001). Overall, dry eye symptoms increased significantly with longer daily smartphone usage.

Table 3: OSDI scores according to daily smartphone usage time			
Daily usage time	**N**	**Mean OSDI ± SD**	**P value**
< 1 hour	52	18.6 ± 15.3	0.001*
1–5 hours	138	24.7 ± 17.9	
> 5 hours	110	31.8 ± 20.4	

Table 4 shows OSDI scores in relation to smartphone usage characteristics. Participants using a protective filter had lower scores (21.3 ± 16.9) compared to those without (28.9 ± 19.5) (p = 0.003). Shorter viewing distance was associated with higher symptoms: <30 cm — 30.7 ± 19.6, 30–50 cm — 23.8 ± 17.8, and >50 cm — 20.5 ± 16.2 (p = 0.002). Screen brightness also influenced symptoms, with increasing OSDI scores from low (21.4 ± 16.1) to moderate (25.9 ± 18.3) and high brightness (32.6 ± 20.5) (p = 0.005). Overall, absence of protective filter, close viewing distance, and higher brightness were associated with greater dry eye symptoms.

Table 4: OSDI scores according to protective filter, viewing distance and brightness (Smartphone)				
Variable	**Category**	**N**	**Mean OSDI ± SD**	**P value**
Protective filter	Yes	104	21.3 ± 16.9	0.003*
	No	196	28.9 ± 19.5	
Viewing distance	<30 cm	128	30.7 ± 19.6	0.002*
	30–50 cm	142	23.8 ± 17.8	
	>50 cm	30	20.5 ± 16.2	
Screen brightness	Low	96	21.4 ± 16.1	0.005*
	Moderate	154	25.9 ± 18.3	
	High	50	32.6 ± 20.5	

Table 5 presents OSDI scores in relation to computer usage characteristics. Mean OSDI increased with longer daily usage: <1 hour — 20.1 ± 16.2, 1–5 hours — 25.7 ± 18.4, and >5 hours — 30.4 ± 20.3 (p = 0.012). Participants using a protective filter had lower scores (22.8 ± 17.5) compared to those without a filter (27.6 ± 19.2) (p = 0.021). Viewing distance also showed a significant association, with higher symptoms at closer distances: <30 cm — 31.5 ± 19.4, 30–50 cm — 23.7 ± 17.8, and >50 cm — 21.2 ± 15.9 (p = 0.001). Overall, longer screen time, absence of protective filters, and shorter viewing distance were associated with higher OSDI scores.

Table 5: OSDI scores according to computer usage characteristics				
Variable	**Category**	**N**	**Mean OSDI ± SD**	**P value**
Daily usage	<1 hour	88	20.1 ± 16.2	0.012*
	1–5 hours	146	25.7 ± 18.4	
	>5 hours	66	30.4 ± 20.3	
Protective filter	Yes	72	22.8 ± 17.5	0.021*
	No	228	27.6 ± 19.2	
Viewing distance	<30 cm	92	31.5 ± 19.4	0.001*
	30–50 cm	168	23.7 ± 17.8	
	>50 cm	40	21.2 ± 15.9	

Table 6 shows the OSDI severity grading among participants. Normal scores (0–12) were seen in 74 subjects (24.7%), mild (13–22) in 82 subjects (27.3%), moderate (23–32) in 76 subjects (25.3%), and severe (33–100) in 68 subjects (22.7%). Overall, participants were fairly evenly distributed across severity categories, with mild symptoms being slightly more common.

Table 6: OSDI severity grading among participants			
OSDI Grade	**Score range**	**N**	**%**
Normal	0–12	74	24.7
Mild	13–22	82	27.3
Moderate	23–32	76	25.3
Severe	33–100	68	22.7

Discussion

The current research showed that almost three quarters of medical students reported some level of symptoms of the dry eye according to the OSDI grading, which implied that the digital eye strain is a significant problem among young adults with long screen time. Earlier studies also reported similar prevalence rates which ranged between 25 and 93%, which is population difference, diagnostic criteria, and exposure duration (Coles-Brennan et al., 2019) [9]. We are just as prevalent as users of computers as well as university students, which indicates that medical students are a particularly high-risk group due to academic load and constant digital education."

Our findings which reveal gender differences with women having much higher OSDI scores than men are consistent with other existing literature that suggests hormonal and tear films stability differences in women. Greater vulnerability in females has been observed in the previous epidemiological studies based on hormonal effects on lacrimal secretion and stability of the ocular surface (Schiffman et al., 2000) [10]. Similar gender difference was also reported with respect to community-based dry eye assessments that were found to report more symptoms among women despite having equal time of exposure (Bandeen-Roche et al., 1997) [11]. Thus, we add to the idea that biological peculiarities can be in play with digital exposure to exacerbate the symptoms.

Throughout our research, a strong correlation between refractive error and increased scores in the OSDI scale is important and it is aligned with the existing literature on the topic which states that uncorrected or corrected refractive error is associated with digital eye strain symptoms. Research comparing visual symptoms related to computers has highlighted that inappropriate focusing effort and accommodation stress are contributing factors to ocular fatigue and dryness (Portello et al., 2012) [12]. Even though the wearing of spectacles is not always linked to severity, visual demand and irregularities in blinking is more evident in the presence of refractive error, which explains the high scores registered among our subjects. Therefore, it seems that refractive status is a significant contributing factor and not the use of spectacles alone.

Among the key discoveries of this paper, it is important to note the gradual increase in the OSDI scores as the time spent on daily smartphone and computer use increases. Those individuals who used their devices over 5 hours per day reported significantly higher scores relative to those who used over 1 hour. There are numerous reports on the association of similar relationships where chronic exposure causes a significant ocular symptom and tear instability (Simavli et al., 2014) [13]. A different study also showed that those who spent most of the day on computers had a mean OSDI of approximately 31, which was similar to the subgroup with high exposure in our population (Balyen, 2019) [14]. Moreover, major observational studies on lockdown days indicated that more than 95 per cent of the participants reported having at least one of the ocular symptoms following prolonged usage of digital devices (Bahkir and Grandee, 2020) [15]. These consistencies are very much in favor of the dose-response relationship between screen exposure and the severity of the dry eye.

The physiology of this association is thought to be a slow pace of blinking and elevated levels of tear evaporation during screen concentration. It has been experimentally demonstrated that visual display terminal users can experience much greater reduction in blinking, and this results in the instability of tear film and evaporative dry eye (Tsubota & Nakamori, 1993) [16] [16]. Subsequent physiological studies affirmed the presence of lacrimal hypofunction and a reduction in tear secretion in users of screens (Nakamura et al., 2010) [17]. This pathophysiological explanation can be justified in terms of our results of increasing weakness of symptoms with increasing period of exposure and increasing brightness because extreme visual concentration and glare additionally inhibit normal blinking behaviour.

We also found that the closer the viewing distance and the lack of screen filters was to significantly increase OSDI scores. Although view distance is not quantified directly in fewer studies, ergonomic literature indicates that shorter working distance increases the accommodative stress and ocular surface exposure, which worsens the symptoms (Coles-Brennan et al., 2019) [9]. High luminance on screens also causes discomfort and blinking inhibition, which is in line with the processes of the case under experimental ocular surface research (Acosta et al., 1999) [18]. Therefore, our findings contribute to useful ergonomic data of the association of environmental determinants and the severity of symptoms.

The other significant observation was graded severity distribution, where there were mild, moderate, and severe symptoms with most students experiencing them. The same severity pattern is reported in the questionnaire-based screening research that focuses on the credibility of the symptom-based assessment in the diagnosis of dry eye (Schiffman et al., 2000) [10]. Population studies have also revealed that the subjective questionnaires used alone can be useful in separating affected people in the community (Bandeen-Roche et al., 1997) [11]. Thus, we find that OSDI is a suitable tool to use in our research and is in line with what the best practices are in screening.

Our findings are further supported by the significant decrease in the reported symptoms after discontinuation of smartphone use in the previous interventional studies. In a study, the four-week cessation of smartphone exposure drastically decreased the corneal epithelial injury and OSDI scores (Moon et al., 2016) [19]. This finding is similar to our finding of a strong correlation between the exposure duration to the device and the severity of the symptoms, which can be reversed by the reduction of exposure.

Altogether, the current results are consistent with the existing body of literature, which claims that length of use of digital devices, strain refraction, and ergonomic factors are all contributing factors to the development of dry eye symptoms among young adults. Nonetheless, our hypothesis is the only study to indicate the influence of viewing distance, screen brightness, and protective filters in a group of medical students, focused on the adjustable behavioral risk factors. The fact that our findings were consistent with past physiological, epidemiological, and interventional research reinforces the fact that digital eye strain is an evaporative form of dry eye disorder that is caused by changed blinking and visual demand.

Conclusion

This cross-sectional research study shows that there are significant prevalence of dry eye symptoms in medical students and that there are definite links between the behavior of using digital display devices and the prevalence of these symptoms. The increased symptom severity was reported more frequently in females and in those students who had refractive errors and spectacles. The relationship between the worsening symptoms and prolonged daily exposure to smartphones and computers was progressive, and the adverse viewing behaviors like closer proximity to the screens and increased brightness of the screens also augmented the symptom burden. On the other hand, use of protective screen filters and distance appropriate viewing seemed to decrease the severity of symptoms. On the whole, the results demonstrate that duration and ergonomic patterns of digital device usage are significant in the etiology and exacerbation of the phenomenon of dry eye syndrome, and prevention awareness and behavioral change among medical students should be addressed.

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