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ORIGINAL ARTICLE

Impact of screen time on digital eye strain and visual acuity among medical students in Peshawar, Pakistan

Iqbal Haider[1], Muhammad Osama[2], Nazli Gul[3]✉, Asad Rehman Khattak[4]

ABSTRACT

OBJECTIVE: To determine the impact of screen time with digital eye strain (DES), visual acuity, and near point of accommodation (NPA).

METHODS: This cross-sectional study was conducted at Khyber Medical College Peshawar, Pakistan. This study included 244 students of 3rd year to 5th year MBBS, who consented to participate. A Snellen chart and Royal Air Force (RAF) rule were used to assess the visual acuity, and NPA. Chi-Square, Pearson Correlation, and multiple regression analyses were conducted using SPSS software.

RESULTS: Out of 244 participants, 181 (74.1%) reported at least one symptom of digital eye strain. Headache (n=87; 35.6%) and eye pain (n=64; 26.22%) were the most common reported symptoms. Refractive error was reported in 98 (40.16%) students, including myopia (n=86; 35.25%), hyperopia (n=12; 4.92%), and astigmatism (n=12; 4.92%). Mobile (n=244; 100%) and Laptop (n=212; 86.90%) were the main electronic gadgets used by participants. Headache, eye pain, tearing of the eyes, eye redness, and itching of the eyes were significantly associated with screen time ($p<0.05$). Headache, blurred vision, itching of eyes, and eye pain were significantly associated with refractive error ($p<0.05$). Multiple regression analysis explains a 32.9% variance in the digital eye strains.

CONCLUSION: This study reveals a concerning 74.1% prevalence of DES among medical students in Peshawar, Pakistan, emphasizing the impact of prolonged screen time on ocular health. Our study reveals a significant link between screen time and DES, with headache & eye pain being the prevalent symptoms. Associations between symptoms, screen time, and refractive errors emphasize the relevance of these factors.

KEYWORDS: Asthenopia (MeSH); Accommodation (Non-MeSH); Ocular (Non-MeSH); Screen Time (MeSH); Visual Acuity (MeSH); Vision, Ocular (MeSH); Refractive Errors (MeSH); Headache (MeSH); Eye Pain (MeSH).

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1. Department of Medicine, Khyber Medical College, Peshawar, Pakistan
2. House Officer, Khyber Teaching Hospital, Peshawar, Pakistan
3. Department of Ophthalmology, Khyber Medical College, Peshawar, Pakistan
4. Final Professional MBBS Student, Khyber Medical College, Peshawar, Pakistan

Cell #: +92-333-9428038
Email✉:drnazli83@gmail.com

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INTRODUCTION

Electronic displays are integral to our daily routines, whether at home, work, during travel, or for leisure. The ubiquity of desktops, laptops, tablets, smartphones, electronic reading devices, and similar digital gadgets in the modern world is undeniable.[1] Prolonged usage of such devices may increase eye discomfort and vision problems. Factors such as screen glare, poor sitting posture, inadequate lighting, and incorrect viewing distances exacerbate the detrimental effects. Blurry vision, dry eyes, neck/shoulder pain, and eye strain have been reported due to increased screen time. These issues are described as computer vision syndrome (CVS) / digital eye strain (DES), and increased device usage cause these symptoms to worsen over time.[2]

A survey including 10,000 respondents in the US pointed out that 65% of people, the majority of females, had self-reported symptoms of DES, with people using two or more devices simultaneously affected more frequently.[3] A cross-sectional study in Spain reported that 76% of students had CVS, with headache and itching being the most common symptoms.[4] Another study in Malaysia identified a prevalence of 89.9% amongst university students, with headache and eye strain being the most frequently reported. Moreover, significantly more symptoms were felt by those on their computer for over 2 hours a day.[5] Similarly, 67.8% and 48% of Pakistani medical students suffered from headaches and eye strain, respectively. A positive association was found between screen time and difficulty in refocusing eyes and eye redness, whereas no association with any other symptoms was found.[6] A descriptive study in Peshawar ranked tired eyes (71.8%), neck/back pain (70.1%), and headache (42.3%) as the top three most common complaints amongst university students, all of which had a significant association with screen usage of more than 5 hours a day.[7]

This study, focusing on uncovering the magnitude of DES and exploring its impact on screen time, near-point accommodation, and visual acuity, addresses a notable gap in the literature. While existing research acknowledges the link between electronic device usage and DES prevalence, particularly in the South Asian population, including

Table I: Screen time association with visual acuity

Symptoms	Response	Number of hours daily				Chi-Square P-value
		1-4 (n=63)	5- 8 (n=149)	Above 8 (n= 32)	Total (n=244)	
Headache	Yes	5 (7.9%)	70 (46.9%)	12 (37.5%)	87 (35.65%)	<0.001
	No	58 (92.06%)	79 (53.02%)	20 (62.5%)	157 (64.34%)	
Eye pain	Yes	3 (4.7%)	47 (31.5%)	14 (56.25%)	64 (26.22%)	<0.001
	No	60 (95.23%)	102 (68.45%)	18 (56.25%)	180 (73.77%)	
Itching of eyes	Yes	5 (7.9%)	33 (22.14%)	9 (28.12%)	47 (19.26%)	0.022
	No	58 (92.06%)	116 (77.85%)	23 (71.87%)	197 (80.73%)	
Eye redness	Yes	3 (4.7%)	33 (22.14%)	10 (31.25%)	46 (18.85%)	0.002
	No	60 (95.23%)	116 (77.85%)	22 (68.75%)	198 (81.14%)	
Blurring of vision	Yes	4 (6.3%)	28 (18.7%)	8 (25%)	40 (16.39%)	0.3
	No	59 (93.65%)	121 (81.20%)	24 (75%)	204 (83.60%)	
Burning of eyes	Yes	3 (4.7%)	22 (14.7%)	4 (12.5%)	29 (11.88%)	0.12
	No	60 (95.23%)	127 (85.23%)	28 (87.5%)	215 (88.11%)	
Shoulder pain	Yes	4 (6.3%)	21 (14.03%)	2 (6.25%)	27 (11.06%)	0.168
	No	59 (93.65%)	128 (85.90%)	30 (93.75%)	217 (88.93%)	
Tearing of eyes	Yes	3 (4.7%)	14 (9.3%)	7 (21.87%)	24 (9.8%)	0.029
	No	60 (95.23%)	135 (90.60%)	25 (78.12%)	220 (90.16%)	
Double vision	Yes	0 (0%)	4 (2.6%)	0 (0%)	4 (1.6%)	0.274
	No	63 (100%)	145 (97.31%)	32 (100%)	240 (98.36%)	

Table II: Screen time association with visual acuity

Visual Acuity		Screen Time				Chi-Square P-value
		Number of hours daily				
		1-4 (n=63)	5- 8 (n=149)	Above 8 (n= 32)	Total (n=244)	
Right Visual Acuity	Low	11 (17.4%)	27 (18.12%)	9 (28.12%)	47 (19.26%)	0.392
	Normal	52 (82.6%)	122 (81.88%)	23 (71.88%)	197 (80.74%)	
Left Visual Acuity	Low	11 (17.4%)	28 (18.79%)	9 (28.12%)	48 (19.67%)	0.424
	Normal	52 (82.6%)	121 (81.21%)	23 (71.88%)	196 (80.33%)	
		Duration in Years				Chi-Square P-value
		1-5 (n=57)	6-10 (n=153)	More than 10(n=34)	Total (n= 244)	
Right Visual Acuity	Low	15 (26.31%)	25 (16.33%)	7 (20.58%)	47 (19.26%)	0.259
	Normal	42 (73.69%)	128 (83.67%)	27 (79.42%)	197 (80.74%)	
Left Visual Acuity	Low	15 (26.31%)	25 (16.33%)	8 (23.52%)	48 (19.67%)	0.225
	Normal	42 (73.69%)	128 (83.67%)	26 (76.48%)	196 (80.33%)	

Pakistan, there is a scarcity of local studies investigating the impact of screen time with DES and visual parameters. By providing research and statistical evidence, this study aims to enhance the understanding of the widespread issue of DES exacerbated by prolonged screen time. It also lays the groundwork for future local and international studies on related concepts.

METHODS

This cross-sectional study was conducted from May 20, 2023 to July 1, 2023, at Khyber Medical College Peshawar, Pakistan. Third-year to Final-year MBBS students were enrolled using a convenient consecutive sampling technique. Based on prior research carried out in Karachi,[8] a sample size of 244 students was determined utilizing the sample size calculator of https://www.calculator.net/ with a population proportion of 67.2%, a confidence interval of 95%, and a margin of error of 5%. Participants of this study comprised of third- to final-year MBBS students who were free from any chronic ophthalmic diseases and consented to be included in the study.

Participants who declined to participate or had conditions such as glaucoma, myasthenia gravis, retinitis pigmentosa, chronic diabetes, chronic renal disease, or hypertension were excluded from the study. While we implemented rigorous exclusion criteria to maintain focus on investigating DES, we acknowledge that this approach might introduce bias. Recognizing that this selection criterion could limit the generalizability of our findings, future research may consider including participants with these medical conditions to enhance understanding of DES across diverse health profiles.

Ethical approval was obtained from The Ethical Board of Khyber Medical College Peshawar (Ref# 298/DME/KMC; Dated 22-5-2023). The Snellen Optometric chart (working distance 20 feet (6.1 m), size: 23x35.5,

Table III: Digital eye strain symptoms association with refractive errors

Digital Eye Strain Symptoms	Response	Refractive Errors		Chi-square P-value
		Yes	No	
Headache	Yes	46 (46.93%)	41 (28.08%)	0.007
	No	52 (53.06%)	105 (71.91%)	
Eye Pain	Yes	39 (39.79%)	25(17.12%)	<0.001
	No	59 (60.20%)	121 (82.87%)	
Itching of eyes	Yes	13 (13.26%)	34 (23.28%)	0.049
	No	85 (86.73%)	112 (76.71%)	
Eye Redness	Yes	17 (17.34%)	29 (19.86%)	0.605
	No	81 (82.65%)	117 (80.13%)	
Blurring of Vision	Yes	25 (25.51%)	15 (10.27%)	0.002
	No	73 (74.48%)	131 (89.72%)	
Burning of Eyes	Yes	14 (14.28%)	15(10.72%)	0.506
	No	84 (85.71%)	131 (89.72%)	
Shoulder Pain	Yes	14 (14.28%)	13(8.90%)	0.102
	No	84 (85.71%)	133 (91.09%)	
Tearing of eyes	Yes	12 (12.24%)	12 (8.21%)	0.167
	No	86 (87.75%)	134 (91.78%)	
Double vision	Yes	2 (2.04%)	2(1.36%)	0.772
	No	96 (97.95%)	144 (98.63%)	

Table IV: Multiple regression analysis of digital eye strain with associated factors

Associated variables	Unstandardized Coefficients		Standardized Coefficients	T	P value
	B	SE	Beta		
(Constant)	0.775	0.404		1.920	0.056
Age	-0.16	0.017	-0.053	-0.976	0.330
Gender	-0.108	0.050	-0.118	-2.150	0.033
Refractive Error	-0.150	0.047	-0.170	-3.211	0.002
Screen time(hrs)	0.382	0.038	0.540	10.122	0.001
Dependent Variable: Digital eye strain; R2 = 0.340; F(4,237)= 30.680					

approximate thickness 0.8 to 1.0 mm) (Gima S.p.A. Via Marconi, 1-20060 Gessate) was used to assess the best corrected visual acuity, at KTH, Peshawar by an ophthalmologist having a minimum 5-year post-graduate experience. Royal Air Force (RAF) rule (2023 Bernell Corporation. 4016 North Home Street, Mishawaka, IN, 46545 USA) (consisting of a 50 cm long rule with a slider holding a rotating four-sided cube) was used to measure NPA (near point of accommodation). The NPA was measured using the RAF Rule and standard targets such as the Times Roman Type face, Reduced Snellen chart, etc. The measurement was carried out with full refractive correction in normal room illumination, where the examiner placed the cheek rest on the inferior orbital margin while holding the ruler. After this, the patients were requested to focus on the target, and the examiner gradually pushed the drum towards the patients' eyes at a stable rate of about 1-2 cm per second.[9,10]

Information regarding participants' biodata, screen time, and DES symptoms was gathered through a meticulously crafted self-administered questionnaire. To ensure the questionnaire's content validity, a pilot study involving ten students was conducted, and these participants were subsequently excluded from the main study to minimize potential biases. Construct validity was assessed using Lynn criteria, involving six subject experts and a predefined threshold of 0.80. Data analysis was performed utilizing IBM SPSS Statistics software (Version 26.0), employing statistical tests such as Chi-square, Pearson correlation, and multiple regression analyses.

RESULTS

Out of 244 participants, 164 (67.2%) were males and 80 (32.8%) were females. Mean age of male and female students was 22.00±1.41 and 21.96±1.43 years respectively.

Most of the study participants were from 3rd year of MBBS (n=131; 53.69%), followed by 5th year MBBS (n=67; 27.46%), and 4th-year MBBS (n=46; 18.85%). Three (1.20%) study participants had ocular diseases (one each having amblyopia, color blindness, and keratoconus), while the remaining all (n=241; 98.80%) were not having any ocular disease. Refractive error was reported in 98 (40.16%) students, including 86 (35.25%) cases of myopia, 12 (4.92%) cases of hyperopia, and 12 (4.92%) cases of astigmatism (Individuals with astigmatism have coexisting myopia or hyperopia, which

is why their count does not add up to the total of refractive errors).

Mobile (n=244; 100%), Laptop (n=212; 86.90%), Television (n=93; 38.10%), and tablet (n=18; 7.40%) were the main electronic gadgets used by participants.

Out of 244 students, 181 (74.1%) individuals reported at least one symptom of DES. Amongst the symptoms, 87 (35.6%) participants reported headache as the main symptom. Headache, eye pain, tearing of the eyes, eye redness, and itching of the eyes were significantly associated with screen time (P<0.05) (Table I).

The frequency of DES symptoms was higher in 131 (53.6%) students with a screen time of 5-8 hours compared to 33 (13.52%) and 17 (6.9%) participants with screen times above 8 hours and below 4 hours, respectively. However, no significant association was found between visual acuity and screen time (p>0.05) [Table II].

The Pearson correlation between screen time and NPA, considering both total daily duration (0.044) and total monthly duration (0.016), revealed a positive correlation. However, the correlation was not statistically significant (p>0.05). Notably, headache, blurring of vision, itching of eyes, and eye pain showed a significant association with refractive error (p<0.05) (Table III). The majority of students, constituting 114 (46.72%), indicated that when they experienced these symptoms, their preferred action was to take a short rest. In contrast, 82 (33.6%), 63 (25.81%), 45 (18.4%), and 11 (4%) chose options such as doing nothing, massaging their eyes and head, frequent blinking of eyes, and consulting doctors, respectively. Among the participants, 58 students (23.7%) had consulted an ophthalmologist due to DES symptoms, and 115 students (47.13%) regarded these symptoms as problematic. Conversely, 129 students (52.88%) did not view these symptoms as a serious problem.

The multiple regression model indicated that gender, refractive error, and daily screen time (in hours) demonstrated significant predictability for the dependent variable, DES, $F(4,237) = 30.680$, ($p < 0.001$). Moreover, the adjusted R square of 0.329 suggests that the model accounts for 32.9% of the variance in DES (Table IV).

DISCUSSION

The prevalence of DES symptoms in our study conducted amongst medical students of Peshawar was 74.1%. According to some of the metanalysis, the pooled prevalence of DES was 66%,[11] 74.4%,[12] and 73.21%.[13] According to a study conducted among health students in Saudi Arabia, 97.3% of them had at least one symptom.[14] Other studies, including those conducted in Spain, Ethiopia, and India, showed a prevalence of 76.6%,[4] 70.4%,[15] and 83%[16] respectively.

In our study, headache was the most common symptom reported (35.6%). Other studies reported teary eyes (40.06%)[17] and headache (61.4%)[18] and (66.5%)[19] as the most common symptom. Multiple variables are involved in the causation of headaches. Some studies hypothesized that prolonged and recurrent adjustments made by the eyes and extraocular musculature result in muscular stress and ocular fatigue, ultimately resulting in headaches.[20]

Our study had a significant association of screen time with headache, eye pain, tearing of the eyes, eye redness, and itching of the eyes. According to a study conducted in Saudi Arabia, using video display terminal devices for longer than 5 hours was associated with experiencing CVS symptoms.[21] Another study has shown a positive association between high screen time and difficulty in refocusing and eye redness, while there was no significant association between high screen time and headache, blurred vision, eye strain, etc.[6] Another study conducted on undergraduate medical and dental students of Karachi also found a significant association between screen time and CVS.[8]

In our study, screen time and NPA were positively correlated but not statistically significant. Close to eyes screen work can cause ciliary muscle spasms, leading to degraded accommodative functions.[22]

This study did not find significant impact between screen time and visual acuity. One of the studies conducted in China also denied an association between these two variables.[23] This research document that headache, blurring of vision, and eye pain were significantly associated with refractive error, whereas one study in Saudi Arabia disproved the association between refractive error and DES symptoms.[24] Studies have shown that people with myopia have higher screen time relative to those who don't have myopia.[25] This finding is also documented in the current study.

Being a cross-sectional study, we cannot establish the causal association between the identified risk factors and DES. This study was conducted among medical students of a single medical college which may limit the generalizability of the findings to a broader population and limit the applicability of the findings to different demographic groups. DES symptoms were self-reported which may introduce subjective bias. In the future, longitudinal studies must be designed to establish the cause-effect association. Expanding the scope of the research could involve conducting multicenter prospective cohorts. National and local Ophthalmology Societies should come forward to develop and implement guidelines for the effective management of DES in our setup to reduce its burden.

It is necessary to guarantee ergonomic environments as a precautionary measure against DES.[26] It is recommended to follow the rule of 20, 20, 20, which says that after every 20 minutes, one should rest for 20 seconds by focusing on an object 20 feet away.[21]

DES is a common problem in medical students and is associated with high screen time and refractive error. It is the need of the hour to increase awareness, especially among the younger generations. In a digitalized world, it is of the utmost importance to focus on preventive measures to alleviate the negative effects of excessive screen time. Students should take DES seriously, consider consulting a doctor on time for these symptoms, and are

advised to incorporate preventive steps like the 20/20/20 rule into their daily routine.

CONCLUSION

This study reveals a notable 74.1% prevalence of digital eye strain symptoms among medical students in Peshawar, Pakistan, highlighting the influence of prolonged screen time on ocular health. Headache emerged as the predominant symptom, and a significant association was identified between screen time and various DES symptoms. While positive correlations with near point of accommodation were noted, they lacked statistical significance, as did associations between screen time and visual acuity. Despite its limitations, the research emphasizes the complex aspects of DES and the need for increased awareness. Further research is required to provide comprehensive insights into DES, improve its effective management, and advance our understanding of ocular health among students and scholars who engage in prolonged screen time.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

IH: Concept and study design, acquisition, analysis and interpretation of data, drafting the manuscript, critical review, approval of the final version to be published

MO & AR: Acquisition of data, drafting the manuscript, approval of the final version to be published

NG: Concept and study design, analysis and interpretation of data, critical review, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request

KMUJ web address: www.kmuj.kmu.edu.pk
Email address: kmuj@kmu.edu.pk