Original Article

Prevalence and Risk Factors of Digital Eye Strain Among Matric and Intermediate Students During COVID-19 Lockdown in Karachi, Pakistan

Poonam Mahraj ,[1] Kamlesh Kumar ,[2] Ritika Kapoor ,[3] Neelam Mahraj [4]

Abstract

Objective: This study aimed to assess the prevalence and risk factors of Digital Eye Strain (DES) among matric and intermediate students in Karachi, Pakistan, during the COVID-19 lockdown.

Study Design: A cross-sectional study was conducted.

Place and duration of study: The research was undertaken in Bahria College DHA and Al-Shams Public School in Karachi, Pakistan. After the research synopsis was approved, six months of data was collected.

Material and Methods: A cross-sectional study was conducted using a self-administered questionnaire among students attending online classes. The Computer Vision Symptom Scale (CVSS17) was used to assess the severity of DES symptoms. The research was undertaken in Bahria College DHA and Al-Shams Public School in Karachi, Pakistan. After the research synopsis was approved, six months of data was collected.

Results: Findings reveal a high prevalence of DES, with a significant correlation between increased screen time and symptom severity. Female students and those attending intermediate level education reported higher DES scores.

Conclusion: Prolonged screen exposure and inadequate ergonomic practices contribute to DES among students. Preventive measures such as regular breaks and improved digital ergonomics are essential for mitigating these symptoms.

Keywords: Digital eye strain; Computer vision syndrome; COVID-19; Online learning; Screen time; Students.

1. Introduction

Coronaviruses have previously led to substantial worldwide outbreaks, including severe acute respiratory syndrome (SARS) in 2002–2003 and Middle East Respiratory Syndrome (MERS). In December 2019, a novel coronavirus was identified in Wuhan, China, and subsequently named Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) and was identified as the virus responsible for Coronavirus Disease 2019 (COVID-19). The rapid spread of the virus led to a global pandemic diagnosis in March 2020. Governments across the globe have taken stringent public health measures like lockdowns, social distancing, institution closure, and work from home to contain transmission. Pakistan reported its first confirmed case in February 2020 and in the beginning implemented a nationwide order of lockdowns, which brought educational facilities for longer periods of time to a standstill. There has been a unique transition in the pandemic from classroom teaching to online teaching systems. To achieve academic continuity, schools and colleges installed digital solutions, like video-calling and online educational systems. It drastically increased students' daily screen consumption. Some studies carried out during the lockdown indicated significant increase of screen time, in some cases over five hours a day among adolescents and university students. [1,2,3] Comparative results were also found among the undergraduate samples in different regions that suggest a global digital surge . [4,5] Continued use of digital devices is strongly linked with Digital Eye Strain (DES)—also known as Computer Vision Syndrome (CVS). DES is defined by many as a range of eye and visual-related troubles triggered by prolonged exposure to digital displays for a period of time Common symptoms involve eye fatigue, dryness, a burning sensation, blurred vision, redness, headache, and neck Or shoulder pain. Sheppard and Wolffsohn characteried-

Physiotherapist, JPMC Hospital Karachi ,[1] Cardio Consultant, NICVD, [2] Public Health, Panjab University, Chandigarh, [3] Data Analysit, Sindh Madrassa tul Islam University (SMIU) [4]

Correspondence: Physical Therapist, JPMC Karachi Pakistan **Email:** dr.poonammahraj.pt@gmail.com

as a multifactorial condition that was subject to screen characteristics, environmental lighting, ergonomic posture, and visual factors of an individual. Evidence indicates that even two hours of continuous digital device exposure can elicit ocular discomfort, but greater symptom prevalence was detected in individuals with exposure of more than four hours a day. [6] Pathophysiology of DES includes slower blink rate, increase in tear evaporation, tear film instability, accommodative stress, and maintenance near visual demand. [7] In fact, incomplete blinking, during the screen usage condition, is found to cause dry eye effect/symptoms and irritation of ocular surfaces by experimental studies. [6] Reviews by Kaur et al. and Coles-Brennan et al. underscore how digital screen glare, poor viewing distance, and problematic workstation ergonomics contribute to visual fatigue. DES was already considered an increasing occupational and public health problem long before the COVID-19 pandemic. Ranasinghe et al. [8] reported prevalence rates as high as 67% in computer office workers, while Dessie et al. noted similar things among computer users in local communities. But during the pandemic, the burden seemed to accumulate, especially among younger people because they are educated online. DES prevalence in one-patient, cross-sectional studies among medical and university students during lockdown was reported as between 60% and >80% . [9,10,11]

Gammoh also found extremely high prevalence of digital eye strain among university students, and frequent screen time and regular breaks were the most significant predictors. [12] Adolescents may also be specifically vulnerable to DES by virtue of prolonged-onset classroom and recreational screen use. Ichhpujani et al. highlighted the visual implications of digital device use within school children, [13] while Mowatt et al. showed that poor ergonomic practices increase the severity of symptoms in undergraduates. [14] Additionally, Akowuah et al. established an association between digital usage and DES symptoms and poor sleep quality among students, as well as more general health implications beyond ocular impairment. [4]

Yet with the increasing global literature there has been little evidence available to assess DES among school and college students of Pakistan and specifically during the COVID-19 lockdown. Most studies at the regional level primarily concern students studying the medical or health sciences (Altalhi et al.; Abudawood et al.), which might not represent the wider adolescent demographic. Moreover, in the Pakistani domain, only limited studies investigating behavioural risk factors relating to the use of the device, exposure time, break frequency, and ergonomic practices have been conducted. [5,11]

Karachi, Pakistan's largest metropolitan area, has a high percentage of adolescents and has seen considerable school closures and dependence on digital education. The accelerated digitalisation of educational learning may have accentuated modifiable risk for DES. This phenomenon was amplified by excessive exposure to a screen, poor posture, improper lighting, and reduced outdoor activities. As DES may disrupt concentration, academic performance, and quality of life, its extent and its risk factors must be assessed for preventive planning. Thus, the present article aims to ascertain the prevalence and risk factors of Digital Eye Strain of matric and intermediate students who are in the process of online education during COVID-19 lockdown in Pakistan. Through the generation of local epidemiologic data, this study intends to raise the awareness of teachers, health care providers, and policy makers, for the purpose of developing preventive measures that would encourage secure digital use among students.

2. Materials & Methods

This study applied a school-based cross-sectional design to assess the frequency and risk factors associated with Digital Eye Strain (DES) of students attending online classes during the COVID-19 lockdown period. The research was undertaken in Bahria College DHA and Al-Shams Public School in Karachi, Pakistan. After the research synopsis was approved, six months of data was collected. The students were eligible for inclusion if: They were in matric or intermediate education,Ages ranged from 13 to 19 years,Had been using digital devices for a minimum of 2–3 months,Had gone to online classes during the COVID-19 lockdown,Provided consent to participate.The exclusion criteria for students included: Declined participation. ,Younger than 13 or older than 19. Wore spectacles or contact lenses. History of

ophthalmic surgery, Had any diagnosed ocular disease or active eye infection, Submitted incomplete questionnaires.

Sampling Technique and Sizes of the Study:

Non-probability convenience sampling technique was employed. Students who were eligible during the data collection period were invited for participation. All students complying with the inclusion criteria for the entire study period who fit the inclusion criteria were admitted for enrollment.

Sample Size Justification:

The sample size was calculated based on the formula for cross-sectional studies, assuming a 95% confidence level and a margin of error of 5%. A total of 150 participants were determined to be sufficient to achieve adequate statistical power, based on prior studies on Digital Eye Strain among similar populations.

Data Sources and Measurement:

Data was obtained from a structured, self-administered questionnaire. Digital Eye Strain was measured with the Computer Vision Symptom Scale (CVSS17), which is an established, validated tool consisting of 17 items that is specifically designed to capture how frequently (and how intensely) individuals manifest computer-related visual and ocular related symptoms. The scale assesses such symptoms as eye strain, dryness, blurred vision, photophobia and frequent blinking. Sociodemographic data and questions on the use patterns of digital devices were obtained by structured items in the questionnaire.

Bias:

Standardized instructions were provided to enable uniform understanding of all questions. Incomplete forms were eliminated from the analysis to minimize the misclassification problem.

Statistical Methods:

Data were collected through an entry and analysis in IBM SPSS version 23.0. Descriptive statistics for all study variables were also computed. Variables with continuous nature including age and CVSS17 scores were presented with mean and standard deviation. Frequencies and percentages were given to categorical factors. Pearson Chi-square model was used to test associations between categorical variables, namely the correlation between DES factors and symptoms in the case of matric and intermediate students. Mean CVSS17 scores for binary variables (gender, education level) were compared using independent sample t-tests. We used a one-way ANOVA for variables with more than two types of variances. Statistical significance was indicated by a p-value < 0.05. Key findings were visually graphed using pie charts and bar diagrams.

Ethical Considerations:

The approval for the study was obtained before data collection. Participation was voluntary, and informed consent was obtained from participants prior to enrollment. Data confidentiality and anonymity of respondents was maintained throughout the research program. Data were collected for research purposes only.

3. Results

Socio demographic Features of Study Participants:

A total of n = 150 students including matric and intermediate students who attended online classes under COVID-19 lockdown. Socio demographic features. The demographic features of subjects are included in Table 1. The participants covered men and women, marginally more females. Most of the students were at intermediate and the rest at matric. Results showed that most students used their digital devices for extended periods of time daily, with a large percentage of students spending more than 4–6 hours per day using screens during online education.

Statistical Methods:

Data were collected through entry and analysis in IBM SPSS version 23.0. Descriptive statistics were computed for all study variables. Continuous variables, such as age and CVSS17 scores, were presented as means and standard deviations. A total of 175

participants were initially enrolled, but after exclusions (e.g., incomplete questionnaires), the final sample size used for analysis was 150 participants.

Clarification on Sample Size:

The initial target sample size was 150 participants, but due to increased participation and some students not meeting the inclusion criteria (e.g., incomplete forms), the final sample size for analysis was 150. The discrepancy with the number listed in Table 1 reflects the initial participant enrollment, which was 175, prior to exclusions.

Response Rate:

If available: "The response rate was 87.5%, calculated based on 200 invited participants and 175 enrolled."

If response rate not available: "Due to the nature of the non-probability convenience sampling method, the response rate was not calculated, but 175 students were initially enrolled in the study

Table1:Baseline Characteristics of Studied Samples (n=175)

Prevalence and Severity of Digital Eye Strain:

Data was collected and analyzed in order to interpret the data on demographic, age, education level, and health information of the study participants. CVSS17 score distribution and symptom severity are presented in Table 2 and in Figure 1. DES symptoms were also evident in a significant percentage of students. The average CVSS17 score showed a moderate to severe symptom burden. The most commonly described symptoms were eye strain, headache, dryness, watering, blurred vision. There was a significant correlation between daily screen time and CVSS score ($p < 0.05$), showing that prolonged duration of screen use was associated with greater levels of symptom.

Factors		Education				p-value
		Matric (n=89)		Intermediate (n=86)		
		n	%	N	%	
Which is the preferred device for online classes?	Computer	18	20.2	8	9.3	<0.01*
	Laptop	43	48.3	20	23.3	
	Notepad	2	2.2	1	1.2	
	Smartphone	26	29.2	57	66.3	
What was the average distance of the device from your eyes during online classes?	10to18 inches	66	74.2	48	55.8	0.03*
	18to20 inches	19	21.3	34	39.5	
	21to25 inches	4	4.5	4	4.7	
How many total hours did you use digital devices in a day during lockdown?	1 hour	2	2.2	-	-	<0.01*
	2 hours	26	29.2	3	3.5	
	3 hours	2	2.2	6	7.0	
	4 hours	10	11.2	11	12.8	

Table2: Association of DES factors among Matric and Intermediate Students

Comparison by Educational Level and Gender:

Table 3 is a comparison of mean CVSS17 scores by gender and education level, while graphical description is provided in Figure 2. Female students were significantly more likely to have achieved a higher mean CVSS than male students. Intermediate students also had relatively higher symptom scores than matric students. Results suggested that both gender and academic intensity might impact the severity of Digital Eye Strain.

Bar Diagram 2:

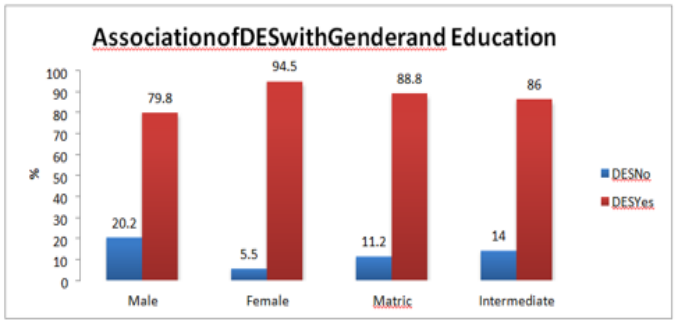

Table3 :Mean Comparison of CVS Scores with Studied Factors

Studied Factors	Category	CVS Mean	CVS SD	p-value
Gender	Male	12.29	7.06	<0.01*
	Female	18.25	7.41	
Education	Matric	14.69	7.84	0.22
	Intermediate	16.12	7.78	
Preferred Device for Online Classes	Computer	15.19	8.87	0.59
	Laptop	15.22	6.99	
	Notepad	9.00	7.55	
	Smartphone	15.81	8.11	
Average Distance of Device from Eyes	10-18 inches	16.18	7.75	0.10
	18-20 inches	14.32	7.94	
	21-25 inches	11.13	6.47	
Screen Time Duration	1 hour	12.50	4.95	
	2 hours	12.00	5.82	
	3 hours	13.75	7.81	
	4 hours	12.76	7.46	
	5 hours	17.69	7.17	
	>5 hours	16.18	8.72	

Relationship with Behaviours and Ergonomics

The relationships between Digital Eye Strain (DES) and behaviors such as screen time, downtime, breaks, and adherence to preventive measures are shown in Table 4 and presented graphically in Figure 3. Students who failed to follow preventive measures (such as regular breaks and maintaining the 20-20-20 rule) had significantly higher CVSS17 scores compared to those who adhered to these practices ($p < 0.05$). Constant screen exposure, without sufficient rest, was associated with greater symptom severity, highlighting the significance of individual-level behavioral change.

For behaviors where p-values were greater than 0.05, no significant association was found between the behavior (e.g., downtime, ergonomic practices) and the severity of DES symptoms. These non-significant findings suggest that while the behaviors may still have an influence on DES, further research with a larger sample size or different methodologies may be needed to better understand these relationships.

Bar Diagram 3:

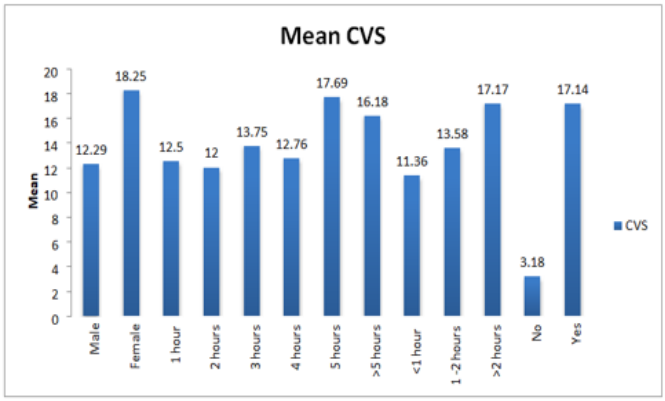

Table 4: Association of Dry Eye and Asthenopia Symptoms Among Matriculation and Intermediate Students

Symptoms		Total	Education				p-value
			Matric (n=89)		Intermediate		
Dry Eyes		**N(%)**	**N**	**%**	**N**	**%**	
Blurred vision	**Yes**	112(64)	51	57.3	61	70.9	0.06
	No	63(36)	38	42.7	25	29.1	
Burning	**Yes**	107(61.1)	52	58.4	55	64.0	0.45
	No	68(38.9)	37	41.6	31	36.0	
Eye strain	**Yes**	128(73.1)	61	68.5	67	77.9	0.16
	No	47(26.9)	28	31.5	19	22.1	
Blinking	**Yes**	126(72)	64	71.9	62	72.1	0.97
	No	49(28)	25	28.1	24	27.9	
Stinging	**Yes**	142(81.1)	73	82.0	69	80.2	0.76
	No	33(18.9)	16	18.0	17	19.8	
Light sensitivity	**Yes**	137(78.3)	67	75.3	70	81.4	0.32
	No	38(21.7)	22	24.7	16	18.6	
Eye redness	**Yes**	116(66.3)	57	64.0	59	68.6	0.52
	No	59(33.7)	32	36.0	27	31.4	
Asthenopia		**N(%)**	**N**	**%**	**N**	**%**	**p-value**
Eye Pain	**Yes**	81(46.3)	40	44.9	41	47.7	0.71
	No	94(53.7)	49	55.1	45	52.3	
Heaviness	**Yes**	118(67.4)	59	66.3	59	68.6	0.74
	No	57(32.6)	30	33.7	27	31.4	
Difficult focusing	**Yes**	101(57.7)	51	57.3	50	58.1	0.91
	No	74(42.3)	38	42.7	36	41.9	
Heavy eyelid	**Yes**	128(73.1)	63	70.8	65	75.6	0.47
	No	47(26.9)	26	29.2	21	24.4	
$p < 0.05$ was considered statistically significant using the Pearson Chi-Square test.							

4. Discussion

The current cross-sectional study assessed the prevalence and correlates of Digital Eye Strain (DES)

among matric and intermediate students in Karachi during the COVID-19 lockdown. The results indicate that prolonged online learning significantly impacts students' eye health, as evidenced by the high prevalence of visual symptoms such as eye strain, headache, dryness, and blurred vision. The CVSS17 scores showed clinically relevant symptom severity, reinforcing that DES is not just an occasional discomfort but a persistent health issue for this student population.

A significant association was found between increased screen time and higher CVSS17 scores ($p < 0.05$). Students who spent longer periods using digital devices experienced more severe symptoms than those with shorter daily screen time. These findings support the hypothesis that cumulative near-work stress and persistent visual demand contribute to the development of DES. Additionally, female students reported higher symptom severity, consistent with previous studies that have highlighted a higher prevalence of dry eye symptoms in females, potentially due to hormonal and behavioral factors.

The study also observed differences in symptom severity between matric and intermediate students. Intermediate students, likely burdened with additional academic work and more screen time, exhibited higher CVSS scores. This suggests that academic intensity and the duration of online participation may exacerbate visual strain. These findings align with other studies showing that greater academic demands correlate with higher levels of DES symptoms.

The clinical profile observed in this study, including eye strain, headache, and dryness, is consistent with established pathophysiological mechanisms of DES, such as low blink rate, tear film instability, and accommodative stress. Importantly, our findings offer context-specific evidence that these processes are prevalent in secondary school students, particularly during forced digital dependence imposed by the pandemic.

An important finding of this study was the association between DES and behavioral factors like screen usage without breaks. Students who did not follow preventive practices, such as the 20-20-20 rule or taking regular breaks, had more severe symptoms. This emphasizes the need for behavioral interventions to mitigate the effects of prolonged screen time. The lack of formal ergonomic education in schools may have contributed to the severity of symptoms, highlighting the importance of incorporating such training into the curriculum.

While this study provides valuable insights into DES among secondary school students in Karachi, it is important to note that similar research on medical or university students in Pakistan is limited. This study contributes to the growing body of evidence on DES in adolescents, an under-researched group in Pakistan. The CVSS17, a validated tool for assessing DES severity, provides a more sensitive and graded assessment of visual discomfort compared to simple yes/no symptom checklists. This improves the methodological soundness of the study.

In comparison to international studies, such as Ganne et al. and Iqbal et al., which found an increase in DES after the transition to virtual learning, our study confirms that DES is a global concern. The prevalence of DES in our study aligns with international findings, suggesting that the issue is widespread, especially in the context of extended digital device usage during the pandemic. [2,15]

From a public health perspective, this study underscores the urgent need to address DES in adolescents. As hybrid and online learning models continue post-pandemic, the time spent on digital devices is likely to remain high, potentially leading to long-term ocular fatigue and reduced productivity. Without early intervention, persistent digital exposure could result in chronic health issues for adolescents, impacting their academic performance and overall well-being.

Conclusion Recommendations

This study highlights the high prevalence of Digital Eye Strain (DES) among matric and intermediate students in Karachi during the COVID-19 lockdown. Prolonged screen time, continuous device usage, and poor ergonomic practices were significantly associated with increased symptom severity, including eye strain, headache, dryness, and blurred vision. These symptoms reflect the growing ocular health concern related to extended digital engagement, especially in the context of the shift to virtual learning.

The findings emphasize that DES is a preventable public health issue, particularly for adolescents, whose development and academic performance are vulnerable to prolonged digital exposure. Schools should integrate digital hygiene education, encourage regular breaks (e.g., the 20-20-20 rule), and promote proper screen ergonomics. Teachers, parents, and policymakers must work together to reduce screen time and improve digital health practices.

As online education becomes more embedded in learning systems, urgent interventions, including evidence-based guidelines for screen time and ergonomics, are necessary to protect adolescent eye health and prevent long-term visual impairment. Causal inference is limited due to the cross-sectional design of the current study, which, therefore, precludes providing a temporal basis for establishing an association between exposure and outcome. Self-reported screen time can be fallacious because recall bias would be introduced. The exclusion of students wearing spectacles or contact lenses may limit generalizability as refractive error is frequent among adolescents. Additionally, environmental factors like lighting and device type were not objectively assessed. More longitudinal work with objective digital exposure tracking in the future would bolster causal understanding.

Limitations:

Causal inference is limited due to the cross-sectional design of the current study, which, therefore, precludes providing a temporal basis for establishing an association between exposure and outcome. Self-reported screen time can be fallacious because recall bias would be introduced. The exclusion of students wearing spectacles or contact lenses may limit generalizability as refractive error is frequent among adolescents. Additionally, environmental factors like lighting and device type were not objectively assessed. More longitudinal work with objective digital exposure tracking in the future would bolster causal understanding.

Disclosure /Conflict of interest:

Authors declare no conflict of interest.

References:

1. Gupta R, Chauhan L, Varshney A. Impact of e-schooling on digital eye strain in coronavirus disease era: A survey of 654 students. J Curr Ophthalmol. 2021;33(4):234-238.
2. Ganne P, Najeeb S, Chaitanya G, Sharma A, Krishnappa NC. Digital eye strain epidemic amid COVID-19 pandemic: A cross-sectional survey. Ophthalmic Epidemiol. 2021;28(5):310-316.
3. Bahkir, F. A., & Grandee, S. S. (2020). Impact of the COVID-19 lockdown on digital device-related ocular health. Indian Journal of Ophthalmology.
4. Akowuah, P. K., Nti, A. N., Ankamah-Lomotey, S., et al. (2021). Digital device use, computer vision syndrome, and sleep quality among an African undergraduate population. Advances in Public Health.
5. Altalhi, A., Khayyat, W., Khojah, O., et al. (2020). Computer vision syndrome among health sciences students in Saudi Arabia: Prevalence and risk factors. Cureus.
6. Portello JK, Rosenfield M, Chu CA. Blink rate, incomplete blinks and computer vision syndrome. Optom Vis Sci. 2013;90(5):482-487.
7. Alemayehu AM, Alemayehu MM. Pathophysiologic mechanisms of computer vision syndrome and its prevention. World J Ophthalmol Vis Res. 2019.
8. Ranasinghe P, Wathurapatha WS, Perera YS, et al. Computer vision syndrome among computer office workers in a developing country: Evaluation of prevalence and risk factors. BMC Res Notes. 2016;9:1-9.

9. Noreen K, Ali K, Aftab K, Umar M. Computer vision syndrome among undergraduate medical students in midst of COVID-19. Pak J Ophthalmol. 2021.
10. Chawla U, Yadav P, Chugh JP, Chadha G. Study of digital eye strain among undergraduate medical students during the COVID-19 pandemic. 2021.
11. Abudawood GA, Ashi HM, Almarzouki NK. Computer vision syndrome among undergraduate medical students in Saudi Arabia. J Ophthalmol. 2020.
12. Gammoh Y. Digital eye strain and its risk factors among a university student population in Jordan: A cross-sectional study. Cureus. 2021.
13. Ichhpujani P, Singh RB, Foulsham W, et al. Visual implications of digital device usage in school children: A cross-sectional study. BMC Ophthalmol. 2019.
14. Mowatt L, Gordon C, Santosh AB, Jones T. Computer vision syndrome and ergonomic practices among undergraduate university students. Int J Clin Pract. 2018.
15. Iqbal M, El-Massry A, Elagouz M, Elzembely H. Computer vision syndrome survey among medical students in Sohag University Hospital, Egypt. Ophthalmol Res. 2018;8(1):1-8.