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Impact of digital learning during COVID-19 epoch: a cross sectional study on eye strain among university students in humanities from South India

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Abstract

The global outbreak of COVID-19 resulted in mandatory digital learning. Spending long hours in front of digital devices may cause eye problems in students. This study was conducted to; (i) identify the digital eye strain experienced by the online student learners during the pandemic period, (ii) find out the association between digital eye strain and selected variables, and (iii) identify the significant predictors of digital eye strain from selected variables. This retrospective cross-sectional study conducted among 100 postgraduate humanities students from Indian universities during the period of 1st January to 31st March 2021. Study used a pretested self-administered online questionnaire. For sample recruitment, non-probability convenient sampling was used. Data were imported into Microsoft Excel 2007 and analyzed using IBM SPSS 25. The results outlined that more than half of the students, who used digital learning for at least four months experienced mild eye strain and time spent on mobile was significantly associated with intensity of near/far sightedness, increased sensitivity to light, blurred vision. The previous history of eye problems increases the risk of severe eye strain among students (OD= 2.361 at p=0.042). Necessary awareness programs and strategies to prevent such problems should also be considered while shifting education to digitalized platforms. Special screening and frequent check-ups should be given to those students who have a history of eye problems.

Keywords: COVID-19, Digital device, Digital Eye Strain (DES), E-learning, Online education.

Introduction

After the outbreak of novel corona virus disease (COVID-19) in December 2019, the WHO declared COVID-19 as a pandemic on 11th March 2020.[1] As a result, there was a compulsory lockdown in many countries. The educational institutions were also closed since March 2020 worldwide due to this pandemic. There was an uncertainty as to when the schools & colleges would reopen. After that, mandatory e-learning emerged as a method of teaching and learning in schools and universities in most countries. [2,3]

This e-learning has changed the traditional education system into online classes. The online culture has eventually led the students to spend a lot of time in front of a digital device. Spending long hours in front of the computer or mobile screens can cause ocular difficulties in students. [4,5] Prolonged use of these devices may cause a variety of eye problems such as dryness, itching, feeling of foreign body, watering and burning to name a few. These eye problems are collectively called Digital Eye Strain (DES).[6]

There exists ample literature which discusses the development of DES issues after using digital devices. But there is only a little literature that examines the association between DES and different variables such as time spent on digital devices, use of spectacles, eye exercises, adjusting the screen brightness and use of home remedies. The study was aimed to determine the eye strain among Post Graduate (PG) university students in the humanities who took online classes for at least four months and investigate the relationship between DES and other variables during the study period. The specific objectives of the study were to; (i) identify the digital eye strain experienced by the online student learners during the pandemic period, (ii) find out the association between digital eye strain and selected variables, and (iii)

identify the significant predictors of digital eye strain from selected variables.

Subjects and Methods
Study design & participants
The current study was a cross-sectional descriptive survey among Indian postgraduate (PG) humanities students who used online education platforms for more than four months throughout the epidemic. The study was conducted from 1st January to 31st March 2021. The sample size was calculated using the Cochrane formula at 20% prevalence (95% CI & 8% margin of error). A sample of 100 students was selected using non-probability convenient sampling and filtered using inclusion criteria; (i) age between 20-24yrs, (ii) used online learning continuously for more than four months, and (iii) 2nd-year university PG students in humanities subjects.

Data collection/measurement
To measure the eye strain among online student learners, researchers developed a questionnaire with five parts; (1) Personal details, (2) Screen time spending, (3) questionnaire for assessing the symptom frequency, (4) questionnaire for assessing the symptom intensity, (5) self-management techniques including the use of anti-glare glasses, adjusting screen brightness and distance, eye exercises, and using home remedies. The responses to the frequency of symptoms were scored as; never- 0, occasionally- 1, and often- 2. The intensity was marked as none-0, mild-1, moderate- 2, severe-3, very severe- 4.Pretesting was done on ten samples, and Cronbach's alpha reliability coefficient was found to be 0.808 for the frequency questionnaire and 0.949 for the intensity questionnaire. The pretested self-administered questionnaire was sent to the participants and consent in Google forms from 1st January to 31st January 2021. The responses were collected and entered in Microsoft Excel 2007. After cleaning, the data was imported into IBM SPSS version 25 for further analysis.

Statistical analysis
Descriptive analysis was used for demographic variables.Chi-square test and Fisher's exact test were used to find the association between the eye strain and selected variables. The symptom frequency and intensity association were tested with selected variables such as screen time spent on television, mobile, desktop, time spent on e-learning, social media, reading/writing, and measures to counter the symptoms. The digital eye strain was measured and categorised based on quartiles viz; mild (0-25/102), moderate (26-50/102), severe (51-75) and very severe (76-102).

The risk factors of digital eye strain in online learners were predicted using multinomial logistic regression analysis. The regression model involved 'mild eye strain', 'moderate eye strain', and 'severe eye strain' as dependent variables. History of the previous check-up for eye problems, the duration from last eye evaluation, time spent for e-learning, and use of spectacles or contact lenses were the independent variables. We used the 'stepwise method' in the regression model. The use of spectacles and time spent on e-learning was not statistically significant in predicting the eye strain and hence removed from the final regression model. All statistical analysis was set at a 5% ($p<0.05$) level of significance.

Results
The mean age of the study participants was 21.86 ± 0.995, and 89% were females. In this study, 56% of the participants reported a history of previous visual examination as 18% in July – December 2020, 4% in January – June 2020, 13% in 2019, and 21% before 2019. The routine use of spectacles was reported by 34% of the students.

Out of the study samples, 29% reported tiredness often, and 64% reported tiredness occasionally.The sleeping routine was marked as 6-8 hours of sleep in 60% of the samples, 4-6 hours in 21%, 8-10 hours in 15%, <4 hours in 3%, and >10 hrs in only 1% of the students. The screen time spending was more reported with mobile /tablet and less observed with television (Table 1).

Table 1: Percentage distribution of screen time spending among online student learners (n=100).

Duration/day	Television	Mobile/Tablet	Computer desktop/laptop
< 1 hour	58%	1%	39%
1 - 2 hours	25%	10%	23%
2 - 4 hours	7%	25%	13%
4 - 6 hours	8%	32%	15%
6 - 8 hours	2%	20%	8%
>8 hours	0%	12%	2%

Nearly half (47%) of the students spent 4-6 hrs in e-learning, while 31% spent 2-4 hrs. Majority (75%) of the students spent <2hrs on social media platforms. The reported time spent in reading/writing was less than 2 hours in half (51%) of the respondents and more than 2 hours in 49% (table 2).

Table 2: Percentage distribution of screen time spending among online student learners (n=100).

Duration/day	E- learning	Reading/Writing	Social Media
< 1 hour	0%	27%	39%
1 - 2 hours	5%	24%	36%
2 - 4 hours	31%	26%	20%
4 - 6 hours	47%	14%	1%
>6 hours	17%	9%	4%

The most common symptom mentioned by respondents was neck/shoulder or back discomfort (occasionally in 51% of cases and often in 37% of cases), followed by headache (occasionally in 52% and often in 21%) (table 3)

Table 3: Percentage distribution of symptom frequency experienced by online learners (n=100).

Symptom	Frequency		
	Never	**Occasionally**	**Often**
Burning	49%	43%	8%
Itching	42%	47%	11%
Feeling of foreign body	69%	29%	2%
Tearing	40%	48%	12%
Excessive blinking	67%	25%	8%
Eye redness	56%	38%	6%
Eye pain	27%	60%	13%
Heavy eye lids	55%	34%	11%
Dryness	52%	36%	12%
Blurred vision	64%	31%	5%
Double vision	85%	14%	1%
Difficulty focusing near vision	74%	23%	3%
Increased sensitivity to light	39%	53%	8%
Colored halos around objects	79%	21%	0%
Temporary near/far sightedness	70%	26%	4%
Neck/Shoulder/Back pain	12%	51%	37%
Headache	27%	52%	21%

The intensity of the symptom was reported as very severe related to headache (14%), & neck/shoulder/back pain (12%) and severe related to increased sensitivity to light (13%) & eye pain (11%) (Table 4)

Table 4: Percentage distribution of symptom intensity experienced by online learners (n=100).

Symptom	Intensity				
	None	**Mild**	**Moderate**	**Severe**	**Very Severe**
Burning	47%	28%	21%	4%	0%
Itching	45%	21%	24%	9%	1%
Feeling of foreign body	58%	29%	9%	4%	0%
Tearing	42%	22%	26%	9%	1%
Excessive blinking	62%	23%	13%	1%	1%
Eye redness	53%	26%	15%	4%	2%
Eye pain	40%	22%	25%	11%	2%
Heavy eye lids	49%	21%	18%	8%	4%
Dryness	48%	21%	23%	6%	2%
Blurred vision	57%	25%	11%	6%	1%
Double vision	66%	23%	7%	4%	0%
Difficulty focusing near vision	64%	20%	10%	5%	1%
Increased sensitivity to light	44%	22%	20%	13%	1%
Colored halos around objects	68%	20%	9%	3%	0%
Temporary near/far sightedness	63%	20%	11%	5%	1%
Neck/Shoulder/Back pain	28%	8%	36%	16%	12%
Headache	37%	11%	26%	12%	14%

Digital eye strain was found to be mild in 59% of the 100 online student learners aged 20-24 years, moderate in 32 per cent, and severe in 9 per cent. The severe category has a median value of 60, the moderate category has a median value of 35, and the mild category has a median value of 10. (Fig. 1)
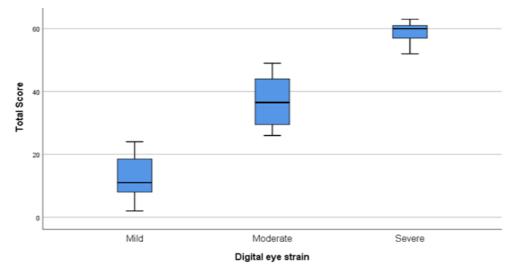

Fig.1: Distribution of digital eye strain among online student learners (n=100).

The digital eye strain in online student learners was significantly associated with previous visual examination (p=0.047), period of last evaluation (p=0.035), and use of antiglare glasses (p=0.003).It was found that digital eye strain was not significantly associated with spectacle use, screen time spending on television, mobile/tablet, desktop/laptop, e- learning, social media, and duration of sleep. Whereas the individual symptoms were associated with other selected variables such as;

1. Screen time spent on E-learning was associated with the intensity of feeling foreign body (p= 0.042) and intensity of heavy eyelids (P=0.043), frequency of eye pain (P= 0.05),
2. time spent on reading and writing was associated with a feeling of foreign body in the eye (p=0.018), frequency of heavy eyelids (p=0.038), frequency of double vision (p= 0.018), frequency of increased sensitivity to light (p=0.029), frequency of temporary near or farsightedness (p=0.029)
3. time spent on television was associated with frequency of itching (p=0.047), and frequency of tearing (p=0.029)
4. time spent on mobile/ tablet was associated with intensity of temporary near/far sightedness (p=0.039), intensity of increased sensitivity to light (p=0.038), difficulty focusing for near vision (p=0.021), intensity of blurred vision (p=0), frequency of colored halos around object (p=0.032), frequency of increased sensitivity to light(p=0.026), and frequency of tearing(p=0.014),
5. time spent on the desktop was associated with frequency of difficulty focusing for near vision (p=0.007),
6. use of spectacles was associated with frequency of blurred vision (p=0.013) and frequency of temporary near/farsightedness (p=0.005).
7. Eye exercise have an influence in the frequency of itching (p=012), the intensity of double vision (p= 0.045), and frequency of heavy eyelids (p=0.048),
8. use of home remedies was associated with the intensity of double vision (p= 0.045), frequency of heavy eyelids (p=0.048),
9. adjusting screen distance have an influence on intense itching (p=0.03), temporary near/farsightedness (p=0.32), and frequency of increased sensitivity to light, and
10. adjusting the screen brightness was associated with the intensity of tearing (p=0.005), frequency of tearing (p= 0.031), and frequency of burning (p=0.016)

Multinomial logistic regression was performed with eyestrain categories (mild, moderate, severe) as dependent variables and history of the previous examination, duration from last evaluation, use of spectacles, and time spent for e-learning, as independent variables. The significant predictors identified by the model were the previous history of eye evaluation and duration from the last evaluation. When comparing students who had no history of previous visual evaluation to those who had, the results showed that students who had no history of previous visual evaluation were less likely to have severe eye strain than those who had. (OD= 2.388 at p= 0.017). The results also depicted that, in students who had a history of last evaluation within one year, the intensity of eye strain will more likely be severe than mild (OD= 2.361 at p=0.042) (table 5).

Table 5: Multinomial logistic regression parameter estimates.

Score Category		OR	df	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Moderate	Previous visual evaluation=No	-0.922	1	0.163	0.109	1.451
	Previous visual evaluation=Yes	0	0			
	Spectacles/contact lenses=No	0.657	1	0.265	0.607	6.136
	Spectacles/contact lenses=Yes	0	0			
	E learning < 4 hours	-0.781	1	0.133	0.165	1.268
	E learning > 4 hours	0	0			
	Last evaluation within 1 year	-0.479	1	0.427	0.190	2.021
	Last evaluation before 1 year	0	0			
Severe	Previous visual evaluation=No	-2.388	1	0.017	0.013	0.656
	Previous visual evaluation=Yes	0	0			
	Spectacles/contact lenses=No	0.194	1	0.827	0.213	6.937
	Spectacles/contact lenses=Yes	0	0			
	E learning < 4 hours	-1.067	1	0.234	0.059	1.995
	E learning > 4 hours	0	0			
	Last evaluation within 1 year	2.361	1	0.042	1.084	103.637
	Last evaluation before 1 year	0	0			
The reference category is: Mild.						

Discussion
Schools and colleges were forced to close for months during pandemics and lockdowns. The education sector had to make a pedagogical change from traditional classroom learning to digital learning platforms. The extensive daily use of these digital devices may provoke ocular and visual problems in students. The current study assessed eye strain among postgraduate humanities students from Indian universities and discovered that more than half of the students had mild eye strain after engaging in online learning platforms for more than four months. Even though nobody reported very severe eye strain, 9% of students reported severe eye strain and 32% moderate eye strain. Similar observations were obtained in another study, which noted that the prevalence of eye strain varied from 25% to 93%.[7] The current study's findings are also consistent with those of another study conducted in Korea, which discovered that increased exposure could harm adolescent

eye health.[8] Another study conducted in Kerala found similar results, revealing that three-fourths of the student population experienced at least one symptom of eye strain while online learning.[9]

In terms of the severity of the symptoms, more students rated headaches as very severe, eye pain, and increased sensitivity to light as severe. Another study indicated that headache was the most prevalent symptom of digital eye strain among adolescents, which is consistent with present study results.[7] The current study findings differ slightly from those conducted among office workers using computers in New York, which discovered that the most common symptoms were tired eyes, dry eyes, and eye discomfort.[10] However, the findings were consistent with those of a study conducted in the United Arab Emirates to identify the pattern of computer usage and related visual problems among university students, which identified headache, burning sensation, and tired eyes are the most common problems students experienced.[11]

It has been discovered that excessive screen time combined with consistent exposure to blue light results in potential long-term risks. The duration of smart phone use has been linked to a variety of ocular symptoms in adolescents.[8] Similar results were obtained in the current study, as time spent on mobile was significantly associated with near/farsightedness intensity, increased sensitivity to light, and blurred vision.

In a study of computer-using office workers in Ethiopia, a previous history of eye illness was significantly associated with computer vision syndrome. When computer workers with a history of eye illness were compared to those with no history of eye illness, they found an ODDS ratio of 3.19.[12] Similar findings were found in current study, where the regression model predicted an ODDS ratio of 2.388 for students with a history of visual evaluation to experience severe eye strain rather than mild, compared to those with no history of eye evaluation. Another study from Bangalore discovered that the duration of computer use and digital eye strain were significantly related.[13] In contrast, in the current study, screen time was only associated with a few symptoms of eye strain and not with the overall score.

Eye exercises, using home remedies to manage eye problems, adjusting screen brightness and screen distance were associated with the symptom frequency and intensity of eye problems, but not with the total score of eye strain.

Limitations and recommendations
The study's limitations were the sample size and sampling method. Because samples were chosen using convenient sampling, there may be an under or over-representation of the population. Given the importance of this research area, the authors recommend additional studies with a large sample size in various categories of online learners. In light of the current study's findings, the authors also suggest that health protocols be developed for students or individuals who must attend long-term online education using digital devices.

Conclusion
In this pandemic era, the shift to novel education strategies such as digital learning is unavoidable. At the same time, the health of the student is a subject of concern. According to the current study's findings, more than half of the students who used digital learning for at least four months experienced mild eye strain. Students who have a history of

eye problems are more likely to experience severe eye strain. This study emphasises the importance of necessary screening and education programmes to prevent potential health problems while implementing long-term online education. For students who have a history of eye disorders, special screening and monitoring strategies should be devised.

Conflict of interest
The authors declare no potential conflicts of interest with respect to research, authorship and publication of this article

References
1. Coronavirus (COVID-19) events as they happen [Internet]. [cited 2021 May 24]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen
2. Rafi AM, Varghese PR, Kuttichira P. The Pedagogical Shift During COVID 19 Pandemic: Online Medical Education, Barriers and Perceptions in Central Kerala. J Med Educ Curric Dev. 2020 Jan; 7:238212052095179.
3. Singh HK, Joshi A, Malepati RN, Najeeb S, Balakrishna P, Pannerselvam NK, Singh YK, Ganne P. A survey of E-learning methods in nursing and medical education during COVID-19 pandemic in India. Nurse education today. 2021 Apr 1; 99:104796.
4. Jayadev C, Sarbajna P, Vinekar A. Commentary: Impact of the COVID-19 pandemic on digital eye strain in children. Indian J Ophthalmol. 2020 Nov; 68(11):2383–4.
5. Ganne P, Najeeb S, Chaitanya G, Sharma A, Krishnappa NC. Digital Eye Strain Epidemic amid COVID-19 Pandemic – A Cross-sectional Survey. Ophthalmic Epidemiol. 2020 Dec 28; 1–8.
6. Sheppard AL, Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. BMJ Open Ophthalmol. 2018 Apr; 3(1):e000146.
7. Mohan A, Sen P, Shah C, Jain E, Jain S. Prevalence and risk factor assessment of digital eye strain among children using online e-learning during the COVID-19 pandemic: Digital eye strain among kids (DESK study-1). Indian J Ophthalmol. 2021 Jan;69(1):140–4.
8. Kim J, Hwang Y, Kang S, Kim M, Kim T-S, Kim J, et al. Association between Exposure to Smartphones and Ocular Health in Adolescents. Ophthalmic Epidemiol. 2016 Jul 3;23(4):269–76.
9. Aqueen Joju, C. V Anthrayose (Andrews), Rakendu Puthiyedath, Niya Babu. Ann Reshma Rajan. Eyestrain and associated problems among undergraduate medical students undergoing e-learning/teaching methods during Covid-19 pandemic. Indian Journal of Clinical and Experimental Ophthalmology. 7(2). 2021.

10. Portello JK, Rosenfield M, Bababekova Y, Estrada JM, Leon A. Computer-related visual symptoms in office workers. Ophthalmic Physiol Opt J Br Coll Ophthalmic Opt Optom. 2012 Sep;32(5):375–82.

11. Shantakumari N, Eldeeb R, Sreedharan J, Gopal K. Computer Use and Vision.Related Problems Among University Students In Ajman, United Arab Emirate. Ann Med Health Sci Res. 2014;4(2):258–63.

12. Dessie A, Adane F, Nega A, Wami SD, Chercos DH. Computer Vision Syndrome and Associated Factors among Computer Users in Debre Tabor Town, Northwest Ethiopia. J Environ Public Health. 2018 Sep 16;2018: e4107590.

13. Ranganatha SC, Jailkhani S. Prevalence and associated risk factors of computer vision syndrome among the computer science students of an engineering college of Bengaluru-a cross-sectional study. Galore Int J Health Sci Res. 2019;4(3):10-5.