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Original Research Article

Impact of increased screen-time on ocular health of medical undergraduate students during COVID-19: a cross-sectional study

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ABSTRACT

Background: Digital Eye Strain (DES) or Computer Vision Syndrome (CVS) is a group of eye and vision related problems that result from prolonged use of digital devices. The usage of digital devices has gone up across the globe, since the declaration of the lockdown due to COVID-19. This study aimed to estimate the prevalence of digital eye strain (DES) due to increased screen time and to determine the factors associated with it, among undergraduate medical students during COVID-19.
Methods: The study analyzed over 280 responses from undergraduate medical students having exposure to digital devices daily for a period more than 6 months during COVID 19 pandemic. A pre-validated questionnaire Computer Vision Syndrome Questionnaire (CVS-Q) which contains 16 symptoms associated with Digital Eye Strain (DES) was used to calculate the DES score. The frequency and intensity of these symptoms adds up to give a total score. A score ≥6 indicated the presence of DES. Data analysis was done using MS Excel and SPSS software.
Results: Digital eye strain was found to be prevalent among 61% of the total respondents. It was seen that daily digital device usage increased to above 5 hours after commencement of the pandemic (p=0·001). Headache was the most common symptom (83.92%). DES has a female gender predominance (p=0.024).
Conclusions: There is a high prevalence of digital eye strain among undergraduate medical students during the pandemic. Awareness should be created among students about impact of DES on ocular health. Measures to reduce DES are recommended.

Keywords: COVID-19, Computer vision syndrome, Eye strain, Ocular health

INTRODUCTION

COVID-19 is an unpredictable predicament and is one of the most dangerous challenges this world has faced and is still facing in our lifetime. The causative agent SARS-COV-2 was first identified among pneumonia patients in Wuhan, China. By the time, the aetiology was identified the disease had spread viciously across continents with high mortality making it inevitable for WHO to declare it as a Public Health Emergency of International Concern on 30 January 2020, and a pandemic on 11 March 2020.[1]

The Government of India confirmed India's first case of COVID-19 on 30 January 2020 in Kerala, when a university student from Wuhan travelled back to the state.[2] As an initial step to curb the spread, lockdown was imposed in the state on March 31st which was further extended.

As the lockdown creepingly disrupted the normal lifestyle of people across the globe, the virtual world came to rescue. Amongst many institutions, professional colleges too shifted their bases to virtual platforms to conduct classes.[3,4] Today, spending 7-12 hours per day in front of

a computer or mobile screen in the name of online classes has become a usual routine for most college students of the Indian community.[3,5]

The young generation of today was already growing up in an increasingly visually demanding world. Electronic devices, video games, tablets and laptops and ubiquitous mobile phones were already being exploited for entertainment and leisure.[6] The COVID 19 pandemic has increased this burden as it left colleges with no other choice but to adopt to e-learning platforms. This has increased the threat of digital eye strain making it an emerging public health problem.

According to American Optometric Association, Digital eye strain (DES) or Computer vision syndrome (CVS) is a group of eye and vision-related problems that result from prolonged use of digital devices.

CVS symptoms occur when there is a need to increase the visual demand to the extent it exceeds a person's visual ability. DES includes a wide range of nonspecific symptoms such as eyefatigue, blurred vision, headaches and even double vision.[7]

Digital device usage causes the blink rate to fall significantly and because of this, the meibomian glands are not stimulated as often to release a proper lipid layer. While working on computers, the gaze angle tends to be higher than what normal near work usually demands leading to faster evaporation and incomplete blinking. Incomplete blinking fails to distribute the tear film properly which when coupled with an inadequate lipid layer presents with dryness of eyes, grittiness or foreign body sensation, burning, and itching of eyes. The constant near work demands the eye to always be in a state of accommodation which when maintained for extensive periods of time, fatigues the visual motor system and causes eye strain and headache.[5]

Continuous usage is not only a stressor on the visual system but also causes circadian disturbances. The blue light emitted by these devices suppresses the secretion of melatonin and shifts the circadian rhythm resulting in sleep disturbances. The continuous exposure to blue light may also result in cumulative phototoxicity causing changes that resemble age related macular degeneration.[4,8]

Those with uncorrected refractive errors, contact lens wearers, people with history of ocular illness, female gender are at risk for the development of more and severe symptoms than their age matched counterparts.[5]

This study aimed to estimate the prevalence of digital eye strain (DES) due to increased screen time and to determine the factors associated with it, among undergraduate medical students during COVID 19.

METHODS

Study design and area

A cross-sectional study conducted among the undergraduate medical students of a private medical institution in Kerala.

Study period

Study was conducted over a period of one month i.e. November to December 2021.

Inclusion criteria

Medical students aged between 18 and 25, who provided valid consent and have been using digital devices such as smartphones, laptop/desktop, tablet, television etc. for a minimum of 6 months were included in the study.

Exclusion criteria

Students wearing contact lenses, undergone LASIK/ any other refractive eye surgery, or on topical anti-glaucoma medication were excluded.

Sample size

The sample size was calculated using the formula

$n = Z^2(1-(\alpha/2))*pq/(p\varepsilon)^2$

Where, p-anticipated proportion of event (Based on a previous study done by Ganne et al, the prevalence of digital eye strain among college students was calculated as 50.6%).[12]

$q = 1-p$

ε = margin of error (precision) = 0.15

$Z*(1-(\alpha/2)) = 1.96$

n = Z*1-(α/2))*pq/(pε)2= (4×50.6×49.4)/ (0.15×50.6)2 = 173

The minimum sample size thus calculated was 173. We received responses from 280 eligible participants.

Sampling technique

Convenient sampling was used. Method of data collection was a self-administered online questionnaire in English generated using Google forms.

The link to the survey was sent by WhatsApp to the different batch groups. Participant was informed about the study in detail and consent was taken prior to the survey. Pre-validated Computer Vision Syndrome

questionnaire (CVS-Q) designed by Segui et al was used to assess the level of DES symptoms.

The questionnaire had three parts: (i) to collect the demographic details, (ii) to understand the pattern of gadget usage, (iii) to assess the degree of eye strain experienced. Grading of DES was estimated using the frequency and intensity of 16 symptoms which included burning sensation, itching in the eyes, foreign body sensation, watering, excessive blinking, redness, eye pain, heaviness in the eyelids, dryness, blurring of vision, intolerance to light, colored halos, double vision, worsening of vision, difficulty in near vision and headache.

Frequency was recorded as follows: Never = symptoms did not occur at all (score 0); Occasionally = sporadic symptoms or once a week (score 1); Often OR Always = 2 or 3 times in a week or almost daily (score 2). Intensity was graded as Moderate (score 1) or Severe (score 2).

The result of (frequency X intensity) was re-coded as: 0=0; 1 or 2=1; 4=2. Final DES was estimated as follows: DES score=$\sum^{16}_{i=1}$ (frequency x intensity) DES score ≥6 was indicative of digital eye strain.

Statistical analysis

The data was entered in 'Microsoft Excel' software and analyzed using SPSS version 16. Descriptive statistics was used to describe the data, frequencies and percentages for categorical variables, and mean with standard deviation for continuous variables. Chi-square test was used for analyzing categorical data. P value less than 0.05 was considered significant.

RESULTS

A total of 309 responses were obtained. All invalid responses were excluded and 280 completed responses were analyzed.

The average age of the respondents was 21.45±1.38 years. A total of 280 students participated in this survey, out of which 99 (35%) were males and 181 (65%) were females. 53% of the respondents live in urban areas, while 47% live in rural areas.

Among 280 participants, 269 (96%) spent most of their digital time on a smartphone compared to a laptop/computer or an iPad/tablet. Only 6 (2.2%) used a laptop or computer the most, while an iPad or tablet was used the most by 5 (1.8%) respondents. 91% have previously heard about Digital eye strain while 9% had no prior knowledge.

We found out that, 61% of the participants have digital eye strain while 39% do not have digital eye strain. The mean DES score was calculated to be 7.13±4.27. (Figure 1). The maximum number of participants (23.6%) have used the inbuilt blue light feature in the device followed by intentional forceful blinking (21%) and placing the screen 4-5 inches below the eye level (18.2%) as preventive measures to reduce digital eye strain. Very few participants have used computer glasses (2.5%) and practiced the 20-20-20 rule (2.1%). Among the students who practiced preventive measures, 38.1% practiced more than one measure. However, 32.5% participants do not practice any of the above eye strain reducing measures (Table 1).

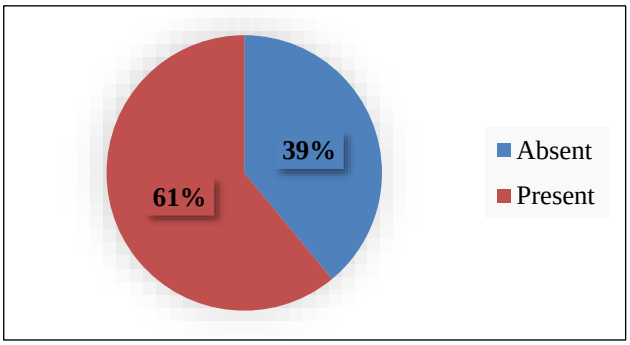

Figure 1: Digital eye strain prevalence among the respondents.

Table 1: Practices adopted by the participants to reduce digital eye strain during the pandemic.

Practices to reduce digital eye strain	Number of respondents (%)
Inbuilt blue light filter in device	66 (23.6)
Intentional forceful blinking at regular intervals	59 (21)
Placing the screen 4-5 inches below the eye level	51 (18.2)
Computer glasses	7 (2.5)
Practice 20-20-20 rule of eyes	6 (2.1)
None of the above	91 (32.5)

The percentage of people using digital devices for 6-8 hours prior to pandemic were 22.86% which increased to 34.28% after pandemic. Likewise, 6.43% using digital devises for 9-11 hours prior to the pandemic increased to 28.57% after the pandemic. The duration of digital device usage, which was 12-14 hours for 1.43 % of respondents before the pandemic, increased to 20% after the pandemic (Figure 2). Most of the participants reported that they spent 2-4 hours each for social media (45%), online classes (44.64%) and entertainment purposes which include movies, gaming etc (40.71%). They spent the least amount of time for other academic purposes like reading soft copies of textbooks, other online material etc (Table 2).

Out of the 16 symptoms of digital eye strain, headache was the most common symptom (83.92%) that was reported by the participants followed by eye pain (69.64%) and watering from eyes (68.57%). The least

common symptoms were double vison (13.21%) and colored halos (11.42%). Digital device usage time has increased significantly after commencement of the pandemic with majority of the students spending more than 5 hours per day with various devices (p=0.001) (Table 3).

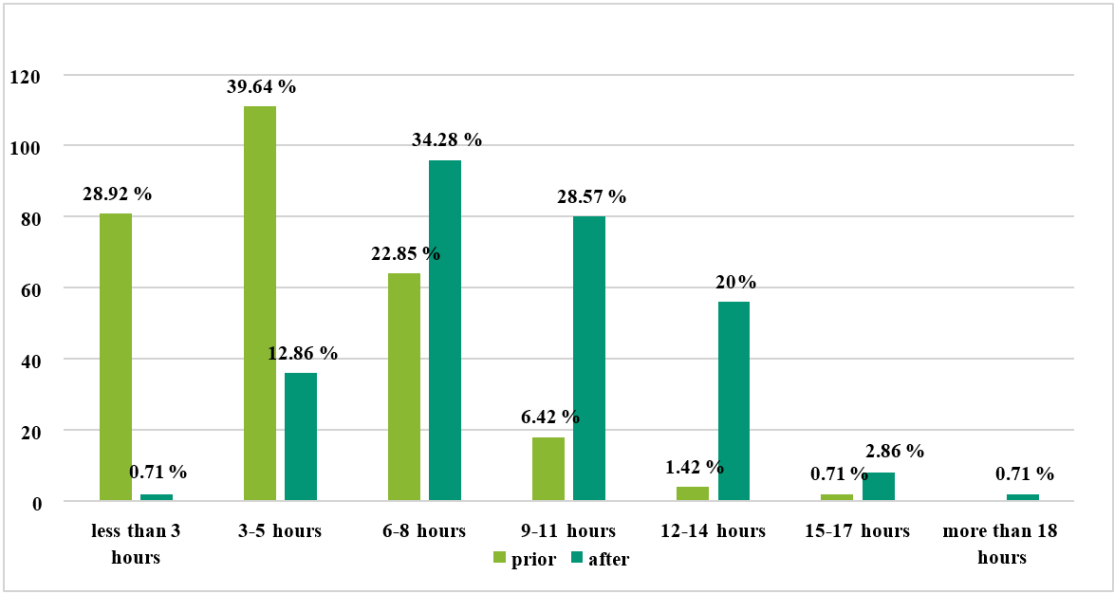

Figure 2: Comparison of duration of digital device usage prior to and after the commencement of pandemic.

Table 2: Comparison of time spent online for various purposes.

No. of hours	Social media (%)	Attending online class (%)	Other academic purpose (%)	Entertainment purposes (%)
<2	67 (23.92)	10 (3.57)	115 (41.07)	66 (23.7)
2-4	126 (45)	125 (44.64)	106 (37.85)	114 (40.71)
4-6	61 (21.78)	103 (36.78)	45 (16.07)	71 (25.35)
6-8	20 (7.14)	38 (13.57)	12 (4.28)	17 (6.07)
>8	6 (2.14)	4 (1.42)	2 (0.71)	12 (4.28)

Table 3: Comparison between digital device usage per day before and after the commencement of the pandemic

Variables	Digital device usage / day		P value
	≤5 hours (%)	>5 hours (%)	
Before pandemic	196 (70)	84 (30)	0.001
After commencement of pandemic	32 (11.51)	246 (88.48)	

Table 4: Association of gender of the participants with digital eye strain

Gender	Without digital eye strain (%)	With digital eye strain (%)	P value
Male	47 (47.5)	52 (52.5)	0.024
Female	61 (33.7)	120 (66.3)	

Table 5: Association between eyestrain reducing practices and digital eye strain

Protective measures	Without digital eye strain (%)	With digital eye strain (%)	P value
Practicing any one of the eye strain reducing measures	64 (33.9)	125 (66.1)	0.020
Not practicing any eye strain reducing measures	44 (48.4)	47 (51.6)	

Digital eye strain was found to be more among female respondents (66.3%) as compared to males (52.5%) and this difference was found to be statistically significant (p value=0.024) (Table 4). DES was found to be higher among those practicing any of the eye strain reducing measures (p=0.020) (Table 5).

DISCUSSION

The prevalence of DES is found to be 61% in this study. An expansion in screen time during the pandemic in contrast with pre-pandemic time was seen in a review led by Gannea et al in Guntur, India. It was noticed that eye strain was higher among participants taking internet-based classes as compared with the overall population (50.6% versus 33.2%).[13] While in a similar study conducted by Mohan Singh and Amit Trivedi in Chandigarh the prevalence of DES among children (Mean age:13±2.8) observed was 50.23%. The explanations behind this commonness may be because of the initiation of online classes and inactive way of life because of lockdown. The DES scores were corresponding to the expansion in the quantity of long stretches of device utilization during the pandemic. [10]

In this study, the digital eye strain is found to be more among female respondents (66.3%) as compared to males (52.5%) and this difference was found to be significant (p value = 0.024). A study of DES due to extended digital device use among undergraduate medical students during the COVID 19 pandemic was conducted by Urmil Chawla at RIO, PGIMS, Rohtak. 84% (n=231) males and 92.03% (n=254) females from the study population had ocular symptoms. Non- ocular symptoms related to digital strain were seen in 70.90% (n=195) males and 82.61% (n=228) females. The prevalence of digital strain was noted to be higher amongst females compared to males in the sample population.[20] This is in accordance with earlier studies which suggest higher incidence of digital strain amongst females.

This study observed that out of 280 respondents, 91% had previously heard about digital eye strain (DES), while 9% had no prior knowledge. A similar study conducted by Patil et al. aimed to assess the awareness, knowledge, and impact of computer vision syndrome (CVS) on sleep quality among medical students. Good knowledge regarding various aspects of CVS was found in 22.46% of individuals, while 53.99% had average knowledge and 23.56% had poor knowledge.[9] It is also noticed that usage of digital device per day has increased tremendously after the pandemic. Before the pandemic only 30% of medical students had used digital device greater than 5 hours, which increased to 88.48% after commencement of the pandemic.

Mohan et al in a study conducted in Madhya Pradesh observed that 36.9% were using digital devices greater than 5 hours in COVID era as compared to 1.8% before COVID era.[15] From this we can infer that there is a drastic increase in usage of digital device during COVID era which can lead to increased incidence of DES. Among the participants, 269 (96%) of them spent most of their digital time on a smartphone compared to a laptop/computer or an iPad/tablet in this study. It was seen in a study done by Usgaonkar et al that the maximum respondents were mobile users (97.85%) spending major time on social media (89.70%).[12] In another study, the most common digital device used was smartphones (n=134, 61.7%). The increased use of smartphones could be due to the user friendly and modifiable nature of the device.[15]

Out of 280 participants, maximum number of participants (23.6%) have used the inbuilt blue light feature in the device followed by intentional forceful blinking (21%) and placing the screen 4-5 inches below the eye level (18.2%) as measures to reduce digital eye strain. Very few participants have used computer glasses (2.5%) and practiced 20-20-20 rule (2.1%) as preventive measure. From the study conducted by Wang et al, measures, such as promoting regular breaks, setting balanced illumination of screen light and room light, and keeping a suitable distance from the screen was found to be effective in students attending online classes.[3] Here 16 symptoms according to CVSQ was analyzed. From the study it is observed that headache is the most common symptom in 235 out of 280 participants (83.9%) followed by eye pain in 69.64% and watering in 68.57%.

The least reported symptom is colored halos (11.42%). Mohan et al in a similar study observed that most common symptoms were itching and headache (53.9%).[15]

This study has few limitations. Reliance on self-reported questionnaires may lead to bias, such as recall or social desirability bias. The sample size may not fully represent the diversity of experiences among all undergraduate medical students in India. The absence of objective assessments of visual function limits the comprehensiveness of the findings related to DES. Other factors, such as stress, lifestyle changes, and overall health, were not controlled for, which could influence the prevalence and severity of DES symptoms reported by participants. While the study indicated a high awareness of DES among participants, the impact of this awareness on their behavior and symptom management was not assessed, which could be an important factor in understanding the phenomenon.

CONCLUSION

In conclusion, this study significantly enhances our understanding of digital eye strain (DES), revealing a prevalence rate of 61% and highlighting the exacerbated effects of prolonged screen time due to increased online learning. By identifying key factors such as increased use of digital devices for both educational and recreational purposes and the reliance on smartphones, this research underscores the urgent need for awareness and preventive

measures to mitigate DES symptoms, particularly in a digitally reliant educational landscape. These findings contribute valuable insights into the public health implications of digital device usage, encouraging further exploration and intervention strategies to protect visual health in the context of ongoing digitalization.

Recommendations

Frequent intervals are advised to be taken by students attending online educational classes to reduce DES. Health education sessions on immediate and delayed consequences of prolonged screen exposure on ocular health must be conducted so as to increase their awareness. Measures of reducing DES such as using of blue light filter, computer glasses and placing the screen 4-5 inches away from the eyes should be taught to vulnerable groups.

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