

Assessment Of Prevalence And Severity Of Digital Eye Strain Amongst Children Using Online Learning During Covid-19

Short title: Digital Eye Strain Amongst Children During Covid-19

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ABSTRACT

Background- The pandemic affected the education of the children and thus online classes were initiated using digital devices, which resulted in excessive use of digital devices. The present study was therefore conducted at a tertiary care center to determine the burden and severity of Digital strain syndrome among children attending online classes during the pandemic.

Methodology- This study was conducted as an online survey-based cross-sectional study on children studying in higher secondary school belonging to the age group of 12 to 16 years attending online classes in Bhopal India. during the pandemic. Using a standard questionnaire, the prevalence and severity of DES were assessed. **Results-** The mean age of children was 15.82 ± 3.93 years. DES was present in 139 (53.9%) children. The most common symptom was headache followed by itching in the eyes. The majority of children had mild DES (37.2%), whereas 13.2% and 3.5% of children had moderate and severe DES respectively. **Conclusions-** We reported a much higher prevalence of DES during the COVID era, which was due to an increase in the time spent on digital devices for online classes. As the education of children is essential, it should be a continuous process. A concentrated effort must be done to increase awareness regarding DES due to digital device usage and e-learning technologies

.INTRODUCTION

COVID-19 pandemic not only had a disastrous effect on the physical health of an individual but also had a significant impact on almost all the determinants of health such as mental, vocational, social, spiritual, emotional, psychological, et cetera.^[1,2] Since the Government of India declared a nationwide lockdown, all routine activities including schools were temporarily shut down. Due to uncertainty regarding the timing of the reopening of school, the online classes were initiated

using digital devices breaking the traditional methods of teaching. As a result, the use of digital devices was increased. This increase in screen time may be associated with the occurrence of ocular problems.^[3]

One of the common manifestations of prolonged use of digital devices is Digital eye strain (DES), which is characterized by various symptoms such as itching, dry eyes, foreign body sensation, blurring of vision, headaches, watering of the eyes, etc.^[4] According to the American Optometric Association, DES is defined as a condition encompassing a wide range of ocular and visual symptoms occurring secondary to prolonged use of digital devices. Overall, the prevalence of digital eye strain has been reported to vary between 25% and 93%.^[5-7]

The digital eye strain is attributed to the emission of short high-energy waves from these devices which tend to penetrate the eyes causing photochemical damage to retinal cells. Thus, making an individual vulnerable to dry eye, age-related macular degeneration, and other eye problems.^[8] As these devices were previously used by adults, so the majority of the studies previously focused on assessing digital eye strain among them.^[9,10] However, the pandemic affected the education of the children, and thus online classes were initiated using digital devices, which resulted in excessive use of digital devices. The present study was therefore conducted at a tertiary care center to determine the burden and severity of Digital eye strain syndrome amongst children attending online classes during the pandemic.

METHODOLOGY

This study was conducted as an online survey-based cross-sectional study on children studying in higher secondary school belonging to the age group of 12 to 16 years attending online classes in Bhopal, India. during the pandemic. Children using gadgets like smart-phone, laptops, and computers for online classes and playing video games during the pandemic were included whereas Children diagnosed with Dry eye disease/ digital strain syndrome before the pandemic and were on treatment for the same; already using eye drops for any other ocular ailments; with refractive errors and not wearing glasses regularly were excluded from the study.

A proforma for the survey was circulated as a google-link form to children fulfilling inclusion criteria and the children were provided a time of 2 weeks duration to submit their responses. All the responses were mandatory. Proforma included questions related to their sociodemographic profile (such as name, age, sex, class), duration of online classes per day, total duration spent in digital device usage, any prior history of refractive errors, digital device usage for other activities, etc. The severity and frequency of symptoms of Digital eye strain syndrome were measured by using a standardized computer vision syndrome questionnaire.^[11] The CVS-Q helps in evaluating the intensity (moderate or intense) as well as the frequency (never, occasionally, or always/often) of digital eye strain by enquiring about 16 eye strain-related symptoms. The frequency and intensity of symptoms were recorded as mentioned in Table 1

The total score was calculated as:

Score = (frequency of symptom occurrence) I x (intensity of symptom)i

Overall, the DES assessment was done by summing the total score and the frequency result was interpreted as 0 = 0; 1 or 2 = 1; and 4 = 2. In case, the total score was 6 or above, the diagnosis of DES was established. The DES was further categorized as mild, moderate, and severe when DES scores ranged from 6 to 12, 13 to 18, and 19 to 32 respectively.

Statistical analysis

Data was compiled using MsExcel and analysis was done with the help of IBM SPSS software version 20. Categorical data were presented as frequency and proportion, and continuous data were represented as mean and standard deviation.

RESULTS

The online link was sent to a total of 389 students fulfilling the inclusion criteria and of them, 258 children responded and submitted. The mean age of children was 15.82 ± 3.93 years.

In our study, children belonging between 12 to 16 years of age were included and the majority of children belonged to the 14 to 16 years of age group (52.3%). About 55% of the children were males and only 45% were females. The majority of the children were students of class 11th. The average duration of time spent in online classes and overall digital device usage was 5.8 ± 2.3 hours and 6.9 ± 3.5 hours respectively. Table 2

In our study, out of 258 individuals, DES was present in 139 (53.9%) children. Figure 1

The above table represents the frequency and severity of symptoms of DES in children attending online classes. Table 3

As shown in figure 2, the majority of children had mild DES (37.2%), whereas 13.2% and 3.5% of children had moderate and severe DES respectively. Figure 2

DISCUSSIONS

To contain the spread and transmission of the COVID-19 pandemic, the Central and State governments announced a nationwide lockdown, which led to a temporary closure of all offices including educational institutions. Technology was the only tool during that period with which people were connected and this mode was utilized to provide formal education to children enrolled in various schools all over the country.^[12] Various online platforms such as Zoom, Google classroom, Microsoft teams, etc. were used as educational platforms for taking online classes.^[9] Due to the lockdown, the movement of all the individuals outside their homes for any activity including recreational activities was hampered. Thus, the use of digital devices increased as children were at home all the time.^[13] Apart from combating the pandemic, a new challenge appeared i.e. digital eye strain.^[12] In our study, we included children belonging to the age group of 12 to 16 years attending online classes. The mean age of children was 15.82 ± 3.93 years and about 55% of the children were males suggesting slight male predominance. The digital eye strain or computer vision syndrome in children using digital devices has been reported to be similar and three potential mechanisms have been proposed. These include extraocular, accommodative, and ocular surface mechanisms.^[14] Extraocular mechanisms suggest that usage of digital devices may be associated with musculoskeletal symptoms such as stiffness of the neck, backache, headache, shoulder pain, etc. These features are mainly due to postural problems

secondary to an improper sitting position, unsuitable chair table height, no proper placement of computer screens, and incorrect distance between the computer screen and eyes, leading to excessive stretching or forward bending.^[15,16] Another postulated mechanism is accommodative mechanisms, which cause double vision, blurring of vision, myopia, presbyopia, and poor accommodative reflex.^[14] These changes have been linked with increased engagement in near work, which is very demanding.^[17] The third postulated mechanism is reduced blink reflex which causes dryness of the eyes and contributes to features of digital eye strain. It has been postulated that incomplete blinking is more relevant to dry eyes rather than reduced blinking as the eyelids do not completely cover the cornea in an incomplete blink reflex affecting the stability of tear film.^[17,18] Apart from these mechanisms, increased exposure of the corneal surface due to horizontal gaze looking at a computer screen along with reduced tear production increases digital eye strain.^[17]

Overall, the prevalence of digital eye strain in our study population was 53.9%. Our study findings were concordant with the findings of **Amarnath et al**, in which the prevalence of DES was 51%.^[19] Similarly, the prevalence of DES in a study by **Mohan et al** was 50.23%.^[3] However, **Pallai D et al** conducted a study to assess digital eye strain in children during the pre-COVID era and reported a prevalence of 18.2%.^[20] These findings suggest that the burden of DES increased from 18.2% during the pre-COVID era to more than 50% during the pandemic. This was confirmed by comparing the mean duration of time spent on the usage of digital devices, which was 6.9 ± 3.5 hours in our study as compared to 1.5 ± 1.7 hours in the reference study.^[21] The severity of symptoms was also assessed in our study. Out of 258 students, 37.2% of children had mild DES 13.2% had moderate and 3.5% of children had severe DES. However, the burden of DES in children according to **Aldukhayel et al** was 69.8%, with 33.1%, 20.8%, and 15.9% of children having mild, moderate, and severe DES.^[21] In a study by **Mohan et al**, about 26.3% of children had mild, 12.9% of children had moderate and 11.1% of children had severe DES.^[4]

In the present study, the most common feature of DES was headache (52.3%), followed by itching in the eyes (48.8%). Similarly, **Amarnath et al** also reported itching and headache to be the most common complaints attributed to 54% and 53% of children respectively.^[19] Our study findings were supported by the findings of **Simon et al** in which the most symptom was headache (69.9%) followed by itching of the eyes (47.7%).^[12] **Mohan et al** reported itching followed by headache as the most common symptom of DES.^[3]

The study had certain limitations, first, the study was conducted as an online survey, and the response rate was low. Second, the symptoms may have been underestimated or underreported by some students. As the questionnaire we circulated was based on subjective symptoms, there may be some recall bias.

CONCLUSIONS

We reported a much higher prevalence of DES during the COVID era, which was due to an increase in time spent on digital devices for online classes. As the education of children is

essential, it should be a continuous process. A concentrated effort must be done to increase awareness regarding DES due to digital device usage and e-learning technologies.

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LEGENDS

Table 1: Frequency distribution of data

Frequency		Score
NEVER	symptoms did not occur at all	0
OCCASIONALLY	sporadic symptoms or once a week	1
OFTEN OR ALWAYS	2 or 3 times a week or almost daily	2
Intensity		
Moderate		1
Intense		2

Table 2- Distribution according to baseline variables

Baseline variables		Frequency (n=258)	Percentage
Age (years)	12-14	123	47.7
	14-16	135	52.3
	Mean±SD	15.82±3.93	
Sex	Male	142	55
	Female	116	45
Class	9 th	79	30.6
	10 th	78	30.2
	11 th	81	31.4
	12 th	20	7.8
Average duration of online classes		5.8±2.3 hours	
Average duration spent on digital device usage		6.9±3.5 hours	

Table 3- Distribution according to intensity and severity of various symptoms

	Never	Occasionally of moderate intensity	Occasionally of severe intensity	Always of moderate intensity	Always of severe intensity
Burning in eyes	134 (51.9)	62 (24)	31 (12)	24 (9.3)	7 (2.7)
Itching in eyes	132 (51.2)	56 (21.7)	39 (15.1)	22 (8.5)	9 (3.5)
Foreign body sensation in eyes	134 (51.9)	67 (26)	34 (13.2)	15 (5.8)	8 (3.1)

Watering/tearing in eyes	139 (53.9)	54 (20.9)	32 (12.4)	30 (11.6)	3 (1.2)
Excessive blinking of eyes	136 (52.7)	45 (17.4)	38 (14.7)	32 (12.4)	7 (2.7)
Redness in eyes	144 (55.8)	46 (17.8)	35 (13.6)	21 (8.1)	12 (4.7)
Pain in eyes	133 (51.6)	55 (21.3)	34 (13.2)	28 (10.9)	8 (3.1)
Heaviness in eyelids	121 (46.9)	58 (22.5)	34 (13.2)	25 (9.7)	20 (7.8)
Dryness in eyes	130 (50.4)	48 (18.6)	37 (14.3)	30 (11.6)	13 (5)
Blurring of vision	138 (53.5)	57 (22.1)	46 (17.8)	12 (4.7)	5 (1.9)
Double vision	137 (53.1)	61 (23.1)	28 (10.9)	23 (8.9)	9 (3.5)
Difficulty in focusing near object	175 (67.8)	46 (17.8)	32 (12.4)	4 (1.6)	1 (0.4)
Halos around objects	189 (73.3)	39 (15.1)	18 (7)	9 (3.5)	3 (1.2)
Increased sensitivity to light	154 (59.7)	41 (15.9)	35 (13.6)	20 (7.8)	8 (3.1)
Headache	123 (47.7)	49 (19)	42 (16.3)	24 (9.3)	20 (7.8)
Worsening of eyesight	155 (60.1)	35 (13.6)	39 (15.1)	21 (8.1)	8(3.1)

Figure 1- Burden of digital eye strain in children

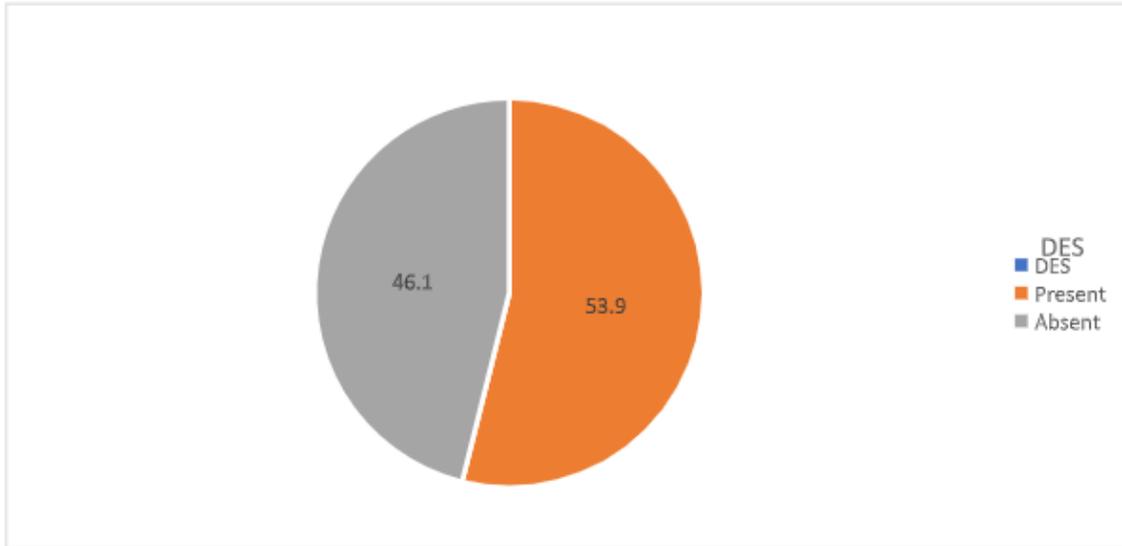


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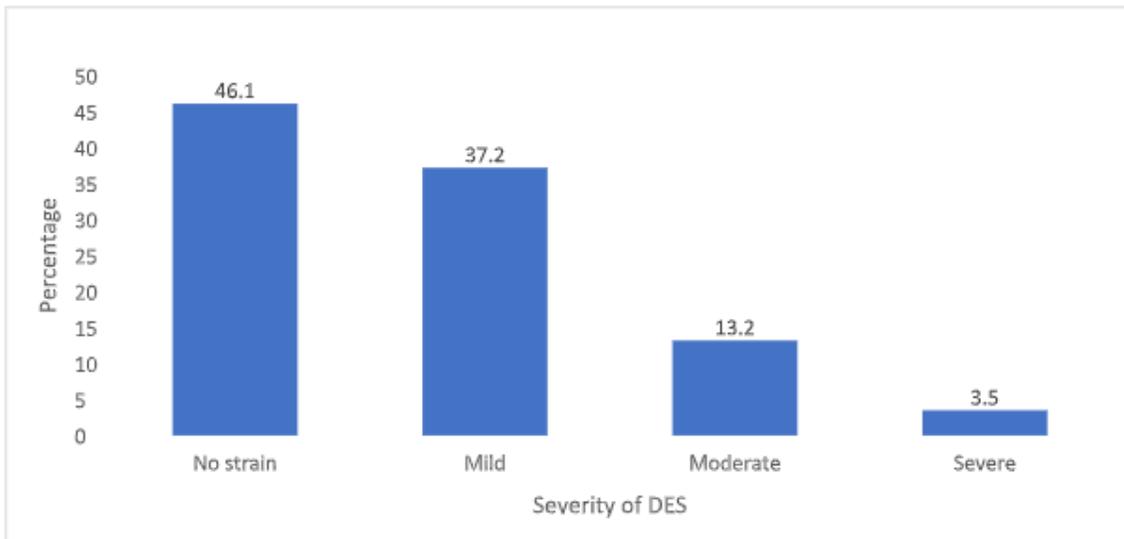


Figure 2- Severity of DES