

Digital Eye Strain among Children in South India: Prevalence and Risk Factors during the COVID-19 Pandemic- Case Study

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

Editor(s):

- (1) Dr. Panagiotis Tsikripis, University of Athens, Greece.
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- (1) Anil Kumar Verma, Dr. Radhakrishnan Govt. Medical College, India.
(2) Satyanarayana Addala, Jawaharlal Nehru Technological University, India.
Complete Peer review History: <https://www.sdiarticle4.com/review-history/70801>

Case Study

Received 26 June 2021
Accepted 27 July 2021
Published 05 August 2021

ABSTRACT

Aim: To study the prevalence, risk factors, and symptoms of digital eye strain among children who attended online classes during the COVID -19 pandemic in Karnataka (South India).

Methods: A Cross-sectional study of the students between 7 to 16 years of age was done. The children, along with the help of their parents, were asked to fill the online survey form. The questionnaire was based on the Computer Vision Syndrome questionnaire, evaluating the total duration of the digital device used before and during the Covid era, the symptoms of DES, its severity, and frequency.

Results: 300 participants responded to the questionnaire, of which 42.9% were males with a mean age of 13 ± 1.75 years. The mean duration of digital devices used during the pandemic era was 4.1 ± 1.3 hour which was nearly three times more than the pre-Covid era (1.5 ± 1.7 hours). 42% (n=126) were using digital devices for more than 5 hours compared to 2.7% (n=81) before the Covid era and the most common digital device used being the smart phones (n=186(62%).

The prevalence of DES in our cohort was 51% (153/300); of these, 26% were mild, 13% were moderate, and 11% were severe. The most common symptoms were itching and headache (54%

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and 53%), respectively. Multivariate analysis revealed age >14 years ($p=0.04$), male gender ($p=0.004$), smartphone use ($p=0.04$), use of device > 5 hours ($p=0.006$) and mobile games for more than 1 hour per day ($p=0.05$) as independent risk factor for DES in children.

Conclusion: The prevalence of DES among children in the COVID era has increased. This study emphasizes the side effects of prolonged use of devices, type of device, and distance from the digital device that can harm the ocular surface. Hence, both parents and the children need to be aware of this, try to reduce screen time, and follow a good healthy lifestyle.

Keywords: CVS; digital eye strain; lifestyle; children.

1. INTRODUCTION

The year 2020 has made a global impact on every section of society because of the corona virus disease. One of the most common problems encountered during this period was Digital eye strain.

Digital eye strain also known as computer vision syndrome includes a wide range of ocular and visual symptoms. The symptoms can be categorised into accommodative or binocular vision stress and symptoms associated with dry eye [1].

Digital eye strain was observed among computer users ever since the first screen based devices were introduced [2]. The gradual shift of using computers exclusively for work to using them extensively in one's everyday life has turned DES in to a very serious health problem in among nearly 90% of the computer users [3]. In fact it has penetrated into the general well being and quality of life.

DES can be identified and evaluated using several questionnaire and objective assessments. A wide range of treatment protocols have been set up to correct DES which includes correction of refractive errors, management of dry eyes, incorporating regular screen breaks, looking into vergence and accommodative problems more seriously.

There has been a substantial increase in the engagement with digital device across all age groups during this pandemic period. The elderly age group have shown a rapid rise from 45 % in the pre Covid era to 73 % within the past one year [4]. In a recent study that was conducted in India it showed that individuals above 60 years of age preferred to use laptops and desktops to browse the internet while the younger age groups preferred to use smart phones [5]. Use of social media and multitasking is certainly more prominent among the younger population.

The symptoms related to dry eyes included burning sensation of the eye, irritation, watering and dryness of the eyes where as symptoms related to accommodation and binocular vision stress included strain, pain behind the eyes and headache.

During the earlier days computers were used exclusively only by adults but today millions of children use computers on a daily basis either for their education or for their recreational activities. Though the visual impact of computer use has been studied in adults, little studies have been done on children [6]. Just like adults even children can experience the same symptoms due to computer over use. Increased screen time can cause eye discomfort, fatigue, blurred vision, headaches, dry eyes. This could be due to a combination of factors like poor lighting, glare, improper posture, refractive errors. In most cases the person becomes aware of the problem when the visual demands of the task starts exceeding the visual abilities of the individual to perform the task at ease [7].

Since asthenopia due to increased usage of digital devices can have an impact on their learning and academic performances, further research is mandatory to understand the prevalence and the consequences of this condition among children.

2. METHODOLOGY

A cross-sectional study was done among secondary school children who attended online classes during the covid-19 pandemic for ten months. The questionnaire was prepared, and it was circulated among the kids through an online portal. It mainly consisted of the demographic details of the child, the digital device information, and the DES symptoms as experienced by the student. All the participants were informed about the purpose of the study before the test, and even the parents were guaranteed that the data collected would be used only for research purposes.

The children or the parents were asked to reveal the number of hours spent each day using a smartphone/iPad/computer for their online classes, watching TV, and playing video games. This was compared with the total time that was spent using the digital device before the Covid era.

The DES symptoms, frequency were also recorded. The DES symptoms and the severity were measured using the computer vision syndrome questionnaire (CVS-Q). The CVS-Q evaluated the intensity as mild, moderate, or severe; frequency of the symptoms as never, occasionally- once a week, often or like 2 or 3 times a week, or almost daily. The eye strain symptoms included burning sensation, itching of the eyes, foreign body sensation, watering, excessive blinking, eye pain, heaviness in the eyelids, dryness, blurred vision, double vision, and intolerance to light; colored halos and headache were also recorded.

The overall assessment was done based on the total score known as the DES score. If the total score was more than 6 points, the child was considered to be suffering from DES. The DES score was further classified as mild (DES score

between 6-12), moderate (DES score = 13-18), and severe (DES score = 19-32).

The data was collected and statistically analyzed using the SPSS software. The associated risk factors were analyzed by univariate and multivariate logistic regression with age, gender, type of device used, and duration spent in front of the device. For the univariate analysis, the chi-square or Fischer's exact test was used, while for multivariate analysis, multiple logistic regression analysis was performed to identify the independent risk factors. A p-value less than 0.05 was considered statistically significant.

3. RESULTS

A total of 300 children/parents responded to the questionnaire, all of them were attending online classes. The mean age in the study group was 13 ± 1.75 years, of which 143(42.9%) of them were males. The average time spent in front of the digital device during the pandemic period was 4.1 ± 1.3 hours which was much higher compared to the pre-Covid era of 1.5 ± 1.7 hours. 42% (n= 126) were using a digital device for more than 5 hours per day compared to 2.7% before the Covid era, and 53% (n=159) had online classes for more than 2 hours per day.

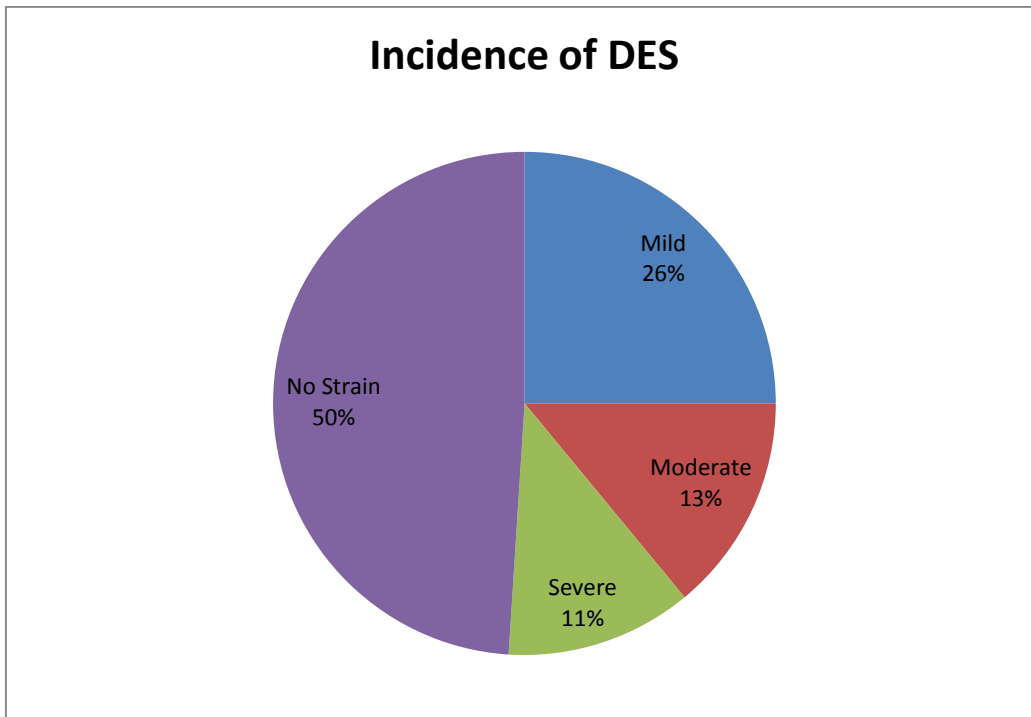


Fig. 1. Showing the incidence of Digital Eye Stain in our study group

In our study it was observed that smart phones were the most commonly used digital device (n= 186)(62%). In total, 32% (n= 96) of children used digital devices at a distance of less than 18 inches or 45 cm. The most common symptom associated with DES was itching (54%) and headache (53%) while double vision and seeing halos around the objects were the least common symptoms (11%) and (21%) respectively.

The prevalence of DES in our cohort was 51% (153/300), of which 26% were mild, 13%

were moderate, and 11% were severe. DES was significantly associated with male gender, smart phone use, the duration for more than 5 hours, distance from the device less than 18 inches in univariate analysis. The multivariate analysis revealed that age more than 14 years, male sex, smart phone preference over the other digital devices, and use of the digital device for more than 5 hours as the independent risk factors of DES in children.

Table 1. Risk factors for DES

Risk Factor	OR	95%CI	P
Age >14 years	2.15	1.0-4.5	0.03
Male gender	4.3	1.8-9.3	0.0004
Smart phone preference	3.1	1.6-6.8	0.004
Digital device >5 hours/day	3.4	1.7-7.7	0.0006
Distance of screen from eyes<18 inches	0.7	0.3-1.8	0.69
Mobile games > 1 hour day	8.2	2.9- 22.1	0.0001

Table 2. Frequency and intensity of symptoms

Symptom	Never	Occasionally -moderate intensity	Occasionally -severe intensity	Often - moderate intensity	Often-severe intensity
Burning	104	76	54	37	29
Itching	100	79	52	47	22
Foreign body sensation	145	69	37	35	14
Watering	155	58	44	25	18
Increased blinking	139	68	45	34	14
Redness	154	65	37	32	12
Pain	145	67	44	27	17
Heaviness	159	65	43	18	15
Dryness	166	55	37	25	17
Blurring of vision	162	56	34	32	16
Double vision	201	45	22	18	14
Difficulty in accommodation	154	67	36	34	9
Halos	197	39	34	26	4
Increased sensitivity to light	143	67	49	37	4
Headache	100	78	57	46	19
Worsening of eye sight	132	63	47	35	23

4. DISCUSSION

4.1 Covid

Due to corona virus, schools had to be closed down to halt the transmission impacting more than 1.5 billion students worldwide [8]. Schools had to switch from the presential system to online learning, increasing the usage of digital devices. Another drawback was the restriction for outdoor activities, which led to the increased time, spent using digital devices. Prolonged activity on smart phones and video games has lead to DES and accommodative problems among children.

4.2 Des Symptoms

In our study, the prevalence of DES was 51%. A study conducted in a private school in rural north India, showed the prevalence of DES as 18.2 % which was lesser in comparison to a study done in a school in urban north India (54%) [9]. The increased prevalence of DES in our study could be attributed to the increased visual demand of digital devices used due to the online classes during this Covid era. Compared to the pre-Covid era, there was a significant increase in the mean duration of digital device usage from 1.5 ± 1.7 hours to 4.1 ± 1.3 hours.

In our study, the most common symptom was itching and headache tallying up to 54 % and 53%, respectively which was similar to a study done by Elangoven et al. [10] where the most common symptom was headache 54.3% and burning sensation 56.7 %.

4.3 Risk Factors

Our study observed that age >14 years, male sex, smart phone usage, and duration more than 5 hours were the independent risk factors for DES in children. Visual symptom scores among the digital device users were more in females than males, as shown in a study done by Shiga et al. [11].

In our study, children more than 14 years of age were at a higher risk of DES. It is similar to the study done by Raghav et al. [12] where the DES was more among the older age group. The older age group children spent more time on digital devices, mainly smart phones, leading to a higher prevalence. Apart from that, the longer duration of online classes in higher grades than in lower grades is another contributory factor.

In our study among the digital devices, preference over smart phones was an independent risk factor. Usage of smart phones for a long duration can decrease the blink rate, reduced tear circulation, and even dry eyes. Since smart phones are used with a shorter viewing distance due to their small screen size, asthenopia symptoms were more common.

4.4 Time Spent

In our study the average time spent in front of the digital device was 4.1 ± 1.3 hours. The results were similar to a study in the US, where participants spent close to 4 hours per day on digital devices. However, a study in a rural part of north India showed that the average time spent in front of the system was approximately 2.7 ± 1.5 hours, similar to the time spent by children in rural western India (2.5 ± 1.9 hours), that it was less than our cohort [13].

42% of children were using digital device for more than 5 hours in comparison to 2.7% of children before the Covid era. These results were similar to a survey conducted by Rudra et al. [14] who reported that the average time spent on digital devices, either being on various social media platforms or games or online classes, came up to 5.2 hours per day .

Children less than 10 years of age spent 3.67 hours per day in front of digital devices, while those between 10-12 years spent around 3.93 hours. Children between 12 to 14 years spent 5.32 hours per day and those between 14 to 16 years spent 6.23 hours per day. Children more than 16 years spent 6.66 hours per day on an average in front of digital devices.

A recent study reported that the prevalence of DES was much higher in individuals who spent >4 hours per day on digital devices [15]. Duration in front of the screen was directly proportional to the DES symptoms. Reducing screen time has a direct effect on the symptoms of DES. The rule of 20-20-20 has been advised to minimize asthenopia symptoms. Every 20 minutes, look at something at a distance of 20 feet for 20 seconds.

4.5 Type of Device

In our study, the most common device used for online classes was the smart phone (62%). A study done by Gurumurthy et al. [16] showed that the older age group preferred using laptops and

desktops whereas the younger adult and children spent more time using smart phones.

Another report by Rizwan et al. [17] showed that 87% of the individuals used two or more digital devices simultaneously for multiple tasks. In comparison, only 20 % of children used multiple devices for online classes in our study. In a study done by Raghav et al. [18], smart phones are more commonly associated with dry eyes (77%, $p=0.037$) as compared to other digital devices used by school-going children. The time spent in front of the screen for more than 5 hours would be another significant factor for higher DES scores in our study.

A shorter distance from the screen has also been associated with a higher risk of DES in children. A study done by Nitasha et al. [19] showed that there was an increased incidence of eye strain among students who watched computer screens at a distance less than 50 cm. This could be due to the screen viewing distance and the child's converging ability. However, in our study, there was no significant association between the screen distance and DES among the children in multivariate analysis. Billton et al. [20], in a study, reported that the ideal distance for viewing digital devices should be one foot for mobile phones, two feet for desktops and laptops, and 10 feet for television. According to the American Academy of ophthalmology minimum distance of 25 inches is mandatory while using the computer screen.

In a study conducted in India before the Covid era, only 40% of children were using smartphones while only 3.3 % spent more than 5 hours per day on digital devices. More than 68% of children were using the digital device at a distance of > 18 inches which is similar to a study done by Poojaru et al. [21] in which 56% were maintaining the ideal distance while using the digital device.

4.6 Why You Did the Study

This study aimed to collect information on DES and make the parents and children aware of the harmful effects of digital devices on the eye. The children must follow good ocular hygiene and practices while using digital devices. Children should strictly increase the number of times they blink their eyes, keep the devices at an ideal distance, monitor screen time, and consume a healthy diet rich in carotenoids and green leafy vegetables. Having regular eye check-ups is equally mandatory.

5. LIMITATIONS OF THE STUDY

Our study was a symptom-based questionnaire where the patients had to indicate the frequency and the intensity of the symptoms experienced during digital device use. This was a subjective opinion and varied from one person to another. Secondly, the refractive error of the child was not taken into consideration. Even the usage of masks can affect it as well and the relation with dry eye.

6. CONCLUSION

Our study enhances the increased prevalence of DES among children due to the increased screen time due to the pandemic. The e-learning curriculum has certainly had an impact on the children's ocular health. This study highlights the adverse effects of digital devices on the eye and the need for parents, teachers, and children to follow the good ocular practice to avoid DES.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Questionnaire on Digital Eye Strain among Kids(DESK)

Basic Information

What is the age of your child?

What is the gender of your child?

Which class is your child studying currently?

Which reading format do you prefer?

- Reading from a desktop computer
- Reading from iphone/Smartphone
- Reading from tablet/ipad

Which device do you use for online classes?

- Computer/Desktop
- Laptop
- Smartphone
- Tablet/ipad

What is average distance of the device from the eyes while having online classes?

- 10-18 inches
- 18-20 inches
- 20-25 inches
- >25 inches

How many hours in a day does your child use the digital device during the lockdown period?

- 1hour
- 2hours
- 3 hours
- 4 hours
- 5 hours
- >5 hours

How many hours did the child use digital devices before the lockdown?

- 1 hour
- 2 hours
- 3 hours
- 4 hours
- 5 hours
- >5 hours

How many hours does your child watch TV in a aday?

- <1 hour
- 1 – 2 hours
- >2 hours

How long does your child play videogames using a smart phone?

- <1 hour
- 1-2 hours
- >2 hours

How many hours does your child attend online classes in a day?

- <1 hour
- 1-2 hours
- >2 hours

Has your child experienced burning sensation of the eyes?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced itching of the eyes?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced foreign body sensation in the eyes?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced watering of the eyes?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced redness of the eyes?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced pain in the eye?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced increased blinking of the eyes?

- Never

- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced heaviness of the eye?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced dryness of the eye?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced blurring of vision?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced double vision?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced seeing halos?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced difficulty in focusing near objects?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced 'increased sensitivity to light'?

- Never
- Occasionally of moderate intensity

- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced headache?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

Has your child experienced worsening of eye sight?

- Never
- Occasionally of moderate intensity
- Occasionally of severe intensity
- Always of moderate intensity
- Always of severe intensity

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Peer-review history:
The peer review history for this paper can be accessed here:
<https://www.sdiarticle4.com/review-history/70801>