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**Original Research Article**

# Effects of digital devices usage in children

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## ABSTRACT

**Background:** Aim of study was to assess the impact of digital device use on ocular parameters in children.
**Methods:** A cross-sectional study was carried out wherein patients were grouped depending on the duration of use and the break in between the usage of digital devices. The impact of screen time and break time were correlated with symptoms of digital eye strain and various orthoptic abnormalities in these children.
**Results:** A total of 127 children were enrolled in the study. Most of the children had a screen time exposure of 4-6 hours (41.6%), while the most common finding in respect to orthoptic abnormality was fusional vergence dysfunction (33.9%). The common symptoms in children were headache (91.3%) and eye pain (61.4%). Most of the children took a break time of <10 minutes in an hour (69.3%). Mobile-based devices were associated with fusional vergence dysfunction and accommodative excess (AE) ($p<0.001$). The association between the break time and orthoptic dysfunction was statistically significant ($p=0.001$).
**Conclusions:** Increased screen time and reduced break time between screen usage in our study have been correlated with an increased incidence of orthoptic abnormalities and symptoms related to digital eye strain.

**Keywords:** Digital eye strain, Digital device, Screen time, Children, Orthoptic dysfunction

## INTRODUCTION

Electronic devices are widespread and have become indispensable parts of life. Adults and children use computers and other electronic devices for both academic and recreational purposes. Due to the corona virus disease 2019 (COVID-19) pandemic, there have been various changes in the lives of people which include an increase in online classes, work from home, social networking, online meetings, and an epidemic of webinars.[1] The widespread use of digital screens throughout the day combined with the sudden shift away from the classroom has made life easier but also can cause harm if used improperly. There are a lot of health consequences as a result of prolonged time spent in front of screens and the improper use of technological devices. Digital eye strain (DES) is referred to as a group of vision-related symptoms that result from the continuous use of devices with digital displays such as computers, tablets, and smartphones.[2] The term DES is used in place of computer vision syndrome (CVS) as many individuals do not consider mobiles and tablets as devices causing the above symptoms.

Prevalence of CVS ranges between 64% to 90% among adult computer users and in children, it is found to be 17.9%.[3,4] Almost 60 million people suffer from DES all over the world. A million new cases of DES are reported annually.[5] Very little research has been done to document the effects of digital devices on the physical health of the pediatric age group. There has been no study to document

the effect of prolonged digital device use and its effect on the eye muscle balance.

DES symptoms include dry eyes, blurred vision, eye pain, neck pain, shoulder pain, and headaches.[6] Many of these are transient and usually disappear with a reduction in screen time. The severity is dependent on many factors, such as posture, room illumination, use of screen filters, screen brightness, and distance from the screen.[7]

The objective of the study was to assess the impact of the use of digital devices on ocular parameters in children.

## METHODS

This cross-sectional study was performed in Sankara eye hospital, Bangalore, India from January 2024 to June 2024. Institutional ethical committee approval was taken before the start of this study, and informed consent was obtained from the guardian according to the tenets of the declaration of Helsinki.

The inclusion criteria were-children in age group of 8-18 years with BCVA of 6/6 with spectacle usage for at least 1 month and refractive errors in the range of -3.00 to +3.00 D, <2 D astigmatism, anisometropia <1 D, with the usage of digital devices at least for 1 hour per day. Children with ocular problems like vernal keratoconjunctivitis, strabismus, cataract, and amblyopia, those who have undergone any form of ocular surgery in the past, eye lid disorders like trichiasis, distichiasis, epiblepharon, lagophthalmos or ptosis, previously diagnosed accommodation/convergence problems, systemic conditions like diabetes, thyroid dysfunction, systemic lupus erythematosus, rheumatoid arthritis, and sarcoidosis were excluded from the study.

A questionnaire to note the symptoms and details of gadget use, slit lamp examination, orthoptic examination, cycloplegic refraction and fundus examination were performed. The duration of the digital device was grouped into four according to the number of hours of use: 0-2 h, 2-4 h, 4-6 h and >6 h. Based on the viewing distance, children were grouped into those using mobile-based and computer-based devices. They were categorized into 4 groups based on the break time taken per hour of device use: <10 min, 10-20 min, 20-40 min and >40 min. Orthoptic diagnoses were categorized as fusional vergence dysfunction (FVD), AE, accommodative insufficiency (AI), convergence excess (CE) and convergence insufficiency (CI).

### *Statistical analysis*

Data was entered in Microsoft excel software in codes, and analysis was done with statistical package for social sciences (SPSS-24), IBM software computer package. Categorical variables have been expressed as frequency and percentages. Test of normality was performed by Kolmogorov-Smirnov and Shapiro-Wilk. Association between the variables was evaluated by chi-square test and fisher's exact test. In all the tests of significance, p value less than 0.05 was taken as statistically significant.

## RESULTS

One hundred and twenty-seven children were included in the study. Most of them were female (59.06%). Most of the individuals used the devices for around 4-6 hours (41.6%) (Figure 1).

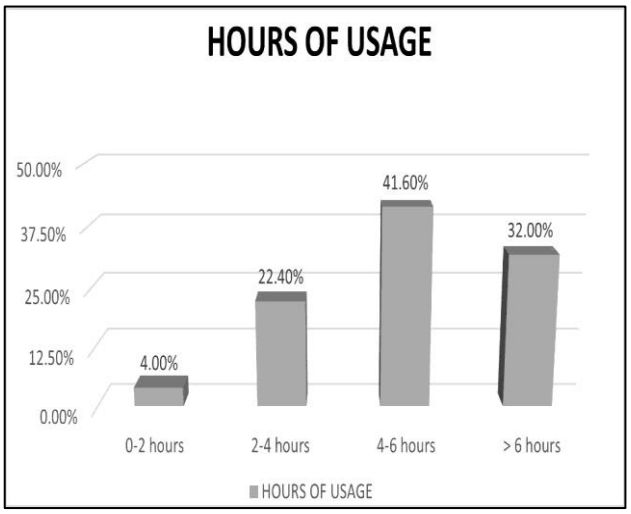


**Figure 1: Percentage of children with various hours of usage of digital devices.**

Headache (91.3%) and eye pain (61.4%) were commonly reported symptoms (Table 1).

**Table 1: Distribution of symptoms in the children.**

| Symptoms | N (%) |
|---|---|
| **Headache** | 116 (91.3) |
| **Eye pain** | 78 (61.4) |
| **Redness in eyes** | 23 (18.1) |
| **Watering** | 27 (21.3) |
| **Blurred vision** | 43 (33.8) |
| **Frequent blinking** | 3 (2.3) |

The children were using four digital devices namely mobile phones, laptops, computers/desktops and tablets. 30.70% were using mobile-based devices (which included mobile phones and tablets), 56.40% computer-based devices (which included laptops and desktops) and 13.38% used both equally. Most of the children took a break time of <10 minutes in one hour (69.3%) (Table 2).

**Table 2: Distribution of break time per hour.**

| Break time | N (%) |
|---|---|
| **<10 minutes** | 88 (69.3) |
| **10-20 minutes** | 35 (27.5) |
| **20-40 minutes** | 3 (2.36) |
| **>40 minutes** | 3 (2.36) |

The subjects were grouped into six categories based on the orthoptic diagnosis (Table 3).

**Table 3: Orthoptic diagnosis in study population.**

| Diagnosis | N (%) |
|---|---|
| **Fusional vergence dysfunction** | 43 (33.9) |
| **CI** | 18 (14.2) |
| **CE** | 4 (3.1) |
| **AI** | 16 (12.6) |
| **AE** | 38 (29.9) |
| **Normal** | 8 (6.3) |

FVD was found in most of the subjects (33.9%), especially in those with more than 6 hours of usage of the digital device.

Refractive error was present in 90% of the subjects. No statistically significant relationship was seen between the refractive error and orthoptic diagnosis. When the association between the type of digital device used and orthoptic parameters was evaluated, it was observed that mobile-based devices were related to FVD and AE ($p<0.001$).

The majority (69.6%) of the children were taking <10 minutes of break every hour of digital usage. A significant association was observed between the break time and orthoptic dysfunction ($p=0.001$). On analysing the relation between the symptoms and the break time, it was found that blurring of vision at the end of the day ($p=0.04$) and watering of the eyes ($p=0.002$) were associated with a decrease in break time (Table 4).

**Table 4: Relation of break time with the symptoms.**

| Break time | <10 min | 10-20 min | 20-40 min | >40 min | P value |
|---|---|---|---|---|---|
| **Headache** | 69.30% | 27.20% | 1.80% | 1.80% | 0.94 |
| **Eyepain** | 74.00% | 20.80% | 2.60% | 2.60% | 0.107 |
| **Redness** | 78.30% | 21.70% | 0.00% | 0.00% | 0.679 |
| **Watering** | 63.00% | 29.60% | 7.40% | 0.00% | 0.044* |
| **Blurred vision** | 52.40% | 47.60% | 0.00% | 0.00% | 0.002† |
| **Frequent blinking** | 66.70% | 33.30% | 0.00% | 0.00% | 0.986 |

*Significant, †Highly significant

## DISCUSSION

DES is a cluster of disorders related to long-term use of digital devices such as laptops, mobile phones, and tablets.[1] The use of digital devices for work and social activities, frequently for many hours daily, has become a norm among people of all ages. While estimating the prevalence of DES poses some difficulties, levels of 50% or higher have been reported in many published studies, thus, implying that a significant proportion of the population is at risk. To deliver optimal care to patients for the disorder, eye care professionals need to be sensitized about the significance of orthoptic assessment in these children. In this study, we assessed the various types, the duration of digital devices being used and their impact on the eyes of the children. To the best of our knowledge, this is the first study in literature evaluating the orthoptic parameters in children using digital devices.

The most common devices used in our study were computer-based devices, including desktops and laptops (56.2%). In our study, most of the children used digital devices for average of 4-6 hours, which was in agreement with studies done by Hayes et al and Shrestha et al.[3,8] Ichhpujani et al reported the DES to be common in individuals spending more than 4 hours per day on digital devices.[4] The duration was also found to be proportional to the symptoms in the Travers et al.[9] In our study, the increase in the incidence of fusional vergence dysfunction is found with more than 6 hours of usage of digital devices.

Portello et al categorized the DES symptoms into two groups: symptoms related to accommodation which included blurred vision for near objects, headache, and eyestrain and symptoms related to dryness which include burning sensation, foreign body sensation, itching, watering, intolerance to light.[10] Most of our subjects using digital devices experienced headaches (91.3%) and eye pain (61.4%) as frequent symptoms. These findings concur with other studies carried out by Mowatt et al and Ichhpujani et al.[4,6] Headache and burning sensation in the eyes were common symptoms reported in school children following digital device usage by Shantakumari et al.[11] Orthoptic abnormalities were seen in 93.7% of our study children. The three commonest abnormalities were FVD (33.9%), AE (29.9%) and CI (14.2%). Shreshta et al found accommodative infacility to be the common problem with digital usage among adults as compared to FVD among children in our cohort. Analysis of the relation of screen time to orthoptic parameter showed an increase in incidence of FVD among 34.1% of the children who used device for more than 6 hours a day. A literature search did not reveal any previous studies to correlate screen time with orthoptic diagnosis.

The usage of multiple devices was common (75.5%) in our study group. However, there was no statistical significance observed between number of digital devices used with the symptoms and the orthoptic parameters. Refractive error did not affect the orthoptic parameters in our group of children. The children who attended our outpatient department and who were included in the study were mostly with refractive errors. Hence, we had

refractive errors in 90% of the children making the study skewed to this relation. Sheppard et al found uncorrected astigmatism and presbyopia to be related to the asthenopic symptoms associated with digital device use.[12] In our study, mobile-based device use was commonly associated with FVD, in agreement with similar studies carried out by Sukanya et al.[13] The use of smartphones was found to be an independent risk factor for DES among children in a study by Mohan et al.[14]

Smartphones have a short viewing distance because of their small screens, thereby increasing asthenopia symptoms. Handheld devices differ from computers in viewing distance, screen size, luminance, and patterns of use. The use of smartphones and tablets results in reduced fusional convergence and a receded near point of convergence. The risk of DES has been associated with a shorter screen distance in children, as reported by Shantakumari et al.[11] This could be attributed to disparity between screen viewing distance and that of convergence. The importance of digital break was analysed by correlating the occurrence of symptoms to the break time and it was noted that blurring of vision at the end of the day was more (52.4%) when the break time is <10 minutes per hour of usage followed by watering of eyes.

### *Limitations*

Our study had a few limitations. Our study was designed on a symptom-based questionnaire that required children to indicate symptoms experienced during digital device use. Children and parents may have recall bias. As enrolment done in pediatric ophthalmology outpatient department, most of the children were symptomatic and had refractive errors. Hence, the study results cannot be extrapolated to all pediatric digital device users.

## CONCLUSION

DES was more pronounced with increased duration and decreased break time during digital device use, especially mobile-based devices. It is therefore recommended that well-informed awareness campaigns be implemented to encourage healthier use of digital devices in order to reduce prevalence of DES and its associated ocular complications.

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