

Visual Impact of Digital Classroom among Students Attending Online Education

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ABSTRACT

Background: COVID-19 outbreak has changed the traditional teaching method of using blackboards to digital devices assisted online classes. Spending long hours in front of digital devices might lead to different ocular problems in children.

Methods: A cross-sectional study was conducted among school-going children attending digital online classes during the COVID-19 pandemic. A web-based online form was used to evaluate the impact of digital classrooms on the visual status of school-going children. Children were selected from 5 randomly selected schools from different parts of Kathmandu Valley who had online classes for at least 2 hours during the COVID-19 pandemic era.

Results: A total of 303 usable responses were obtained from a response rate of 41% with an average age of 10 years. Sixty-four percent of children had online classes up to 6 hours a day and 44% used laptops for online classes followed by smartphones (38%). The most common symptom was headache affecting 39.3% of the children, followed by difficulty seeing bright light (35%) and itching of the eyes (35%). Forty percent of the children felt that their eyes were affected after online class. Multivariate analysis showed that the total duration spent on digital devices was the greatest risk factor associated with the ocular symptoms.

Conclusions: Ocular symptoms and digital eye strain related to the excessive use of digital devices have increased due to the increased duration of online classes. Awareness about the prevention and measures to reduce the adverse effects should be stressed.

Keywords: Computer vision syndrome; digital eye strain; headache; ocular problems; online classroom

INTRODUCTION

On 11th March 2020, World Health Organization (WHO) declared COVID-19, as a global pandemic.¹ To slow the spread, physical distancing and closure of schools, parks etc were adopted.² Globally >1.20 billion students were deprived of physical classroom and switched to in-house quarantine with online learning education system.³ The traditional teaching method of using black/whiteboards changed to digital device assisted online classes. But, spending long hours in front of these devices can lead to digital eye strain (DES).^{4, 5}

DES is associated with prolonged digital device use, characterized by dry eyes, itching, burning sensation, watering, blurring of vision and headaches and its prevalence is estimated to range from 25%-93%.⁶

Although DES has been extensively studied in young

adults, there are limited studies among children. Thus, we aim to report the pattern, symptom and associated risk factors of DES among the Nepalese school children attending online classes during the COVID-19 pandemic. This is probably first of its kind report from Nepal.

METHODS

A cross sectional study was conducted from May 2021 to September 2021 among 303 school going children (aged 6 years to 18 years) attending digital online classes during COVID-19 pandemic. All the students with at least 2 hours of online class during the pandemic were included in the study. Children were selected from the 5 randomly selected schools from different parts of Kathmandu valley.

A web-based online google form which was developed by the authors was used to evaluate the impact of digital

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classrooms on visual status of school going children. (Appendix A) The form had questionnaires divided into four sections. The first section collected demographic characteristics of the participants including age, gender, name of the school and grade. The second section assessed the pattern of use of digital devices of the children. This included the information such as time spent for school works, number of digital devices used by the children, devices used for online class and time spend on digital devices for online classes in a day. Similarly, the third section covered the ocular symptoms like burning, itching, watering, pain around the eyes, blurring of vision, difficulty in changing focus, headache, double vision and difficulty in seeing bright light after attending online classes and the last section included an attitude of children regarding eye examinations after digital classroom. The items included whether the eyes are affected during the exam, attitude on the status of the eye after online class and going for eye checkup after the end of the lockdown. The prepared form was distributed retested among 20 students for pre-testing. Based on the pre-testing, the form was finalized to use for the current study. Confidentiality was maintained regarding the identity and records of online responses.

We obtained prior permission from the school authority for administration of the questionnaire to their students. Informed written consent from the parents or assent from the children was obtained prior to their enrollment in the study. The link for the questionnaire was sent to the children during the online class by Information Technology (IT) unit of those schools. In case of lower secondary school children parent helped in filling the questionnaire while in case of secondary and higher secondary level, child independently filled the questionnaire. Children reluctant to participate, incomplete response forms or late submitted forms were excluded. Ethical review was obtained from the Institutional Review Committee of Institute of Medicine (Reference No. 136 (6-11) E2). The study adhered with the Declaration of Helsinki.

All the data was entered into a MS excel spreadsheet and was analyzed with Statistical Package for Social Science (SPSS) version 21. Logistic regression was done to find out the association of pattern of digital devices with the ocular symptoms. The p value less than 0.05 at 95% confidence interval was considered statistically significant.

RESULTS

The questionnaire was sent to 1134 children of various schools, out of which 464 children responded to the

questionnaire with a response rate of 41% and 161 incomplete responses were excluded so only 303 complete responses underwent analysis. Among 303 children 52.1% (n=158) were male and 47.9% (n=145) were female with the mean age 10.95 ± 2.77 years (6-16 years).

Around 51.5% of children were of primary level and 46.2 % (n=140) children spent about 4-8 hours/day for academic activities during the pandemic period. Around 64 % (n=194) children had online classes up to 6 hours a day and 44.9% (n=136) of the children used laptop for online classes whereas 35% (n=106) of the children didn't use other digital reading materials apart from text book (Table 1).

Table 1. Academic characteristics of the respondents.

Academic characteristics	Frequency	Percent	
Educational state	Primary	156	51.5
	Lower secondary	83	27.4
	Higher secondary	64	21.1
Total duration spent for academic activities/day	<4 hours	128	42.2
	4-8 hours	140	46.2
	>8 hours	35	11.6
Duration of online class per day	< 3 hours	68	22.4
	3-6 hours	194	64
	>6 hours	41	13.5
Type of device used for digital classroom	Computer/ Desktop	23	7.6
	Ipad/Tablets	38	12.5
	Laptop	136	44.9
	Smart phone	106	35
Source of reading materials apart from text books	None	106	35
	Desktop/ Laptop	91	30
	Smart phone	68	22.4
	Tablet/Ipad	38	12.5

Fifty one percent used at least two digital devices a day and 22.1% (n=67) spent greater than 6 hours/day on digital devices. Around 48.2% (n=146) children used their digital device at about 25cm for their online class. Besides online classes, 37% (n=112) subjects used digital devices for playing online games and 35.3% (n=107) watching videos. And 15.8% (n=48) children felt that they didn't have proper set up for digital devices for their online class (Table 2).

Table 2. Pattern of use of digital devices.

Usage of digital device		Frequency	Percent
No. of digital device	One	114	37.6
	Two	155	51.2
	More than 2	34	11.2
Time spent on digital device	< 3 hrs/day	86	28.4
	3-6 hrs/day	150	49.5
	>6 hrs/day	67	22.1
Distance of digital device from the eyes	inch	146	48.2
	18-20 inch	89	29.4
	21-25 inch	40	13.2
	>25 inch	28	9.2
Besides online classes, the other purposes for digital devices use	Complete the classwork and do homework	9	3
	For entertainment	14	4.7
	Guitar/music lessons	2	0.7
	None	12	4.0
	Online games	112	37
	Social media	47	15.6
	Watching videos	107	35.3
Proper setup for placing devices	Yes	255	84.2
	No	48	15.8
	Don't watch	101	33.3
Watching Television	Less than 1 hours a day	91	30
	1-2 hrs per day	81	26.7
	Greater than 2 hrs a day	30	9.9

Eye strain related symptoms expressed by the students during the digital classrooms are documented in Table 3. Majority of children 39.3% (n=119) experienced headache.

Table 3. Eye strain related symptoms.

Ocular Symptoms	Yes [n(%)]	No [n(%)]
Burning Sensation	89 (29.4%)	214 (70.6%)
Itching of the Eyes	105 (34.7%)	198 (65.3%)
Watering of the eyes	88 (29%)	215 (71%)
Pain around the eyes	83 (27.4%)	220 (72.6%)
Blurring of vision	63 (20.8%)	240 (79.2%)
Difficulty in changing focus from distance to near	55 (18.2%)	248 (81.8%)

Headache	119 (39.3%)	184 (60.7%)
Double Vision	23 (7.6%)	280 (92.4%)
Difficulty to see in bright light	106 (35%)	297 (65%)

Surprisingly, 42.2% (n=128) of the children had never visited any eye doctor for eye checkup in their life. Among 47.8 % who had undergone prior ocular examination, 23.8% (n=72) had refractive error and were wearing the glasses during their online class. Regarding the attitude of ocular status after the online class, 40.3% (n=122) children felt that their eyes might have been affected by online class. (Table 4)

Table 4. Ocular characteristics and attitude towards eye examination.

Ocular characteristics	Frequency	Percent
Last date of Eye Examination	Not done till today	128 42.2
	Less than 1 year	75 24.8
	Greater than 1 year	100 33
History of wearing glasses	Yes	72 23.8
	No	231 76.2
Attitude of the children towards eye involvement in the digital classroom.	Yes, affected	122 40.3
	No, not affected	39 12.9
	May be, not sure	142 46.9

Ocular symptoms were associated with the increasing duration of online classes a day. These associations were considerably stronger for respondents having symptoms of watering eyes with online classes of 3-6 hrs a day (OR=3.58, 95% CI 1.41-9.11) and those with the symptoms of difficulty in changing focus from distance to near with online classes of 3-6 hrs a day (OR= 3.87, 95% CI 1.33-11.28). Respondents with online classes of greater than 6 hours a day were more likely to note burning sensation (OR 2.80, 95% CI 1.39-5.63) and double vision (OR 2.88, 95% CI 0.87-9.57). (Table 5)

Respondents with increase in time spent on digital devices were more likely to have burning sensation (OR 2.50 95% CI 1.27-4.92). Reduced working distance on digital devices was more likely to have difficulty in seeing in bright light conditions (OR 2.95 95% CI 1.23-7.08) and difficulty in changing focus from distance to near (OR 2.54 95% CI 0.73-8.77). (Table 4)

Table 5. Association between ocular symptoms and pattern of use of digital device.

Ocular symptoms		Duration of online classes per day			Distance of digital device from the eyes			
		< 3 hrs n (%)	hrs n (%)	>6 hrs n (%)	10-18 inch n (%)	18-20 inch n (%)	21-25 inch n (%)	>25 inch n (%)
Burning sensation	Yes	18 (20.2)	20 (22.5)	51 (57.3)	55 (61.8)	19 (21.3)	10 (11.2)	5 (5.6)
	No	51 (23.9)	143 (66.8)	20 (9.3)	91 (42.5)	70 (32.7)	30 (14)	23 (10.7)
	Adjusted OR (95% CI)		2.77 (1.22-6.31)	2.80 (1.39-5.63)	0.36 (0.12-1.00)	0.80 (0.26-2.38)	0.65 (0.19-2.17)	
Itching of the Eyes	Yes	22 (21)	67 (63.8)	16 (15.2)	56 (53.3)	27 (25.7)	12 (11.4)	10 (9.5)
	No	46 (23.4)	127 (64.5)	24 (12.2)	90 (45.5)	62 (31.3)	28 (14.1)	19 (9.1)
	Adjusted OR (95% CI)		0.99 (0.41-2.40)	1.00 (0.47-2.11)	1.29 (0.46-3.62)	1.27 (0.52-3.12)	0.89 (0.38-2.07)	
Watering eyes	Yes	12 (13.6)	56 (63.6)	20 (22.7)	51 (58)	19 (21.6)	10 (11.4)	8 (9.1)
	No	56 (26.2)	138 (64.5)	20 (9.3)	95 (44.2)	70 (32.6)	30 (14)	20 (9.3)
	Adjusted OR (95% CI)		3.58 (1.41-9.11)	2.00 (0.96-4.16)	1.20 (0.40-3.56)	1.47 (0.56-3.86)	0.74 (0.30-1.81)	
Pain around eyes	Yes	15 (18.1)	52 (62.7)	16 (19.3)	49 (59)	23 (27.7)	8 (9.6)	2 (3.6)
	No	54 (24.5)	142 (64.5)	24 (10.9)	97 (44.1)	66 (30)	32 (14.5)	25 (11.4)
	Adjusted OR (95% CI)		1.57 (0.74-3.36)	1.68 (0.67-4.20)	0.48 (0.11-1.99)	0.34 (0.09-1.24)	0.23 (0.06-0.82)	
Blurring of vision	Yes	13 (20.6)	36 (57.1)	14 (22.2)	39 (61.9)	12 (19)	7 (11.1)	5 (7.9)
	No	56 (23.3)	158 (65.8)	26 (10.8)	107 (44.6)	77 (32.1)	33 (13.8)	23 (9.6)
	Adjusted OR (95% CI)		2.31 (0.89-5.97)	2.40 (1.09-5.31)	1.02 (0.28-3.63)	1.39 (0.44-4.37)	0.59 (0.21-1.67)	
Difficulty in changing focus from distance to near	Yes	9 (16.4)	35 (63.6)	11 (20)	38 (69.1)	7 (12.7)	5 (9.1)	5 (9.1)
	No	60 (24.2)	159 (64.1)	29 (11.7)	108 (43.5)	82 (33.10)	35 (14.1)	23 (9.3)
	Adjusted OR (95% CI)		3.87 (1.33-11.28)	1.97(0.83-4.63)	1.52 (0.396-5.85)	2.54(0.73-8.77)	0.618 (0.21-1.74)	
Headache	Yes	25 (21)	74 (62.2)	20 (16.8)	66 (55.5)	35 (29.4)	13 (10.9)	5 (4.2)
	No	44 (23.9)	120 (65.2)	20 (10.9)	80 (43.5)	54 (29.3)	27 (14.7)	23 (12.5)
	Adjusted OR (95% CI)		1.42 (0.60-3.33)	1.18 (0.57-2.43)	0.452 (0.14-1.45)	0.335 (0.11-0.96)	0.26 (0.09-0.73)	
Double Vision	Yes	6 (26.1)	12 (52.2)	5 (27.1)	16 (69.6)	3 (13)	2 (8.7)	2 (8.7)
	No	63 (22.5)	182 (65)	35 (12.5)	130 (46.4)	86 (30.7)	38 (13.6)	26 (9.3)
	Adjusted OR (95% CI)		2.71 (0.70-10.43)	2.88 (0.87-9.57)	1.46 (0.19-11.04)	2.20 (0.34-13.91)	0.62 (0.13-2.88)	
Difficulty to see in bright light	Yes	21 (19.8)	67 (63.2)	18 (17)	54 (50.9)	25 (23.6)	12 (11.3)	15 (14.2)
	No	48 (24.4)	127 (64.5)	22 (11.2)	92 (46.7)	64 (32.5)	28 (14.2)	13 (6.6)
	Adjusted OR (95% CI)		2.16 (0.91-5.13)	1.74 (0.83-3.62)	2.69 (0.98-7.35)	2.95 (1.23-7.08)	1.96 (0.87-4.44)	

OR: Odds ratio, CI: Confidence Interval

DISCUSSION

In Nepal, 40% of the total population belongs to less than 16 years of age.⁷ The mean age of the children in our study was 10.95±2.77years (6-16 years), which represents the core pediatric population. Learning through the digital platform has become a compulsion during the COVID outbreak. This subsequently has led to increased ocular symptoms during the COVID-19

pandemic due to digital classroom. The current study reported that 62% of the children used more than one digital device. Besides, online class the devices were used mostly for online games (37%), watching videos (35.3%) and for social media (15.6%).

Although school closures may be short-lived, increased access and adoption of such platforms may accelerate the widespread acceptance of digital tools in the longer

term.⁸ According to the American Optometric Association, as little as two hours of continuous digital devices usage per day is enough to bring about the development of an array of eye and vision related problems. Previous studies have reported less than 4 hours of screen time per day for 85% of the students while the student in our study 58% of the children reported they used device more than 4 hours of a screen. This increase in digital device usage is anticipated since the children are increasingly dependent on smart phones and computers during this pandemic where they have no other medium to undertake their everyday activities. But a study from rural part of India have reported only 2.7 ± 1.7 hours of average time spent by the children in front of the screen.⁹

Since the declaration of lockdown due to COVID-19, the usage of digital devices has gone up across the globe, resulting in a challenge for the visual system of all ages. There is a drastic increase in use of digital devices after the initiation of the COVID-19 lockdown and along with it slow deterioration of ocular health of the children. The sudden increase in usage of digital devices and the overall number of hours screen time logged per day have been due to a shift of professional and social activities to web based platforms after the advent of novel corona virus. In the current study 13% of the children spent greater than 6 hours on digital devices which is higher than the study done by Badri et al who reported that the average time spent on gadgets by the students was 5.2 hours per day.¹⁰

In our study, the most common device used for online class was laptops followed by the smartphones. A European study reported that 68% of children regularly used computers and 54% undertook online activities.¹¹ The research done previously has shown that older age groups prefer using laptops and desktops whereas younger adults/children are more likely to prefer smartphones for these purpose.¹² About 60% of the children in our study used more than one device a day. The proportion was much higher in about 87% of the individuals in a study done by Shepard et al, where the subjects used two or more digital devices for multiple tasks.¹³ Almost all the children included in the study had online classes in our study, out of which 77% of the children had greater than 3 hours per day. In a study done by Mohan et al. 49.8% were attending online classes > 2 hours of day.¹⁴ However in a study conducted in India before COVID era, only 40% of the children were using smartphones for school project purposes and only 3.3% spent > 5 hours per day.¹⁵

The high number of hours using digital devices significantly

increases the number of incidence symptoms. In our study, the most common symptom was headache affecting 39.3% (119/303) of the children. Headache could be a presentation of eye strain, undiagnosed refractive error or simply a result of exposure to continuous bright light for unnatural periods of time. This was on a par with the occurrence of the headache in a study done by Bakhir et al in about 43.5% of the respondents.¹⁶ Thirty five percentage of the children experienced difficulty in seeing bright light and itchininess of eyes. Handheld digital device and computer monitors may reduce the blink rate and affect the tear film stability with the risk of developing dry eye syndrome leading to difficulty in seeing bright light and itching sensation in the eyes.¹⁷ Eyeball pain was experienced by 27.4% of the children which can be explained by the undue strain of intrinsic muscles of accommodation which can't fully relax under the viewing distance of digital devices. Another factor may be the paucity of breaks during the classroom. Patterns of ergonomics might also be implicated. The occurrence of eyeball pain was comparable to such symptoms where eye pain was experienced by 29% (118/407) of participants.¹⁶ But another study reported a higher prevalence of 47.63% in computer users in Ethiopia.¹⁸ Blurring of vision was reported by 20.8% of the children. The prevalence of these symptoms was comparable to the study which was reported in 16.5% of the population.¹⁶ Other studies reported a less prevalence of 13.2% and 16.4% in medical and engineering students.¹⁹

Blurring of vision in the child might be due the incidence of myopia progression after the use of digital device. This condition might also be caused by small font size, reduced reading distance, light emission of self-illuminating screens and time-based exposure. There are numerous studies²⁰⁻²² that have shown the association between duration of daily digital screen engagement and myopic progression. Study done by Liu et al reported that every 1 hour increase in daily digital screen use is associated with 1.26 OR higher risk of myopic progression. Using computers (OR 1.813) and using smartphones (OR: 2.02) were shown to be associated with higher risk of myopic progression than television use.²³ Multivariate analysis showed that the total duration spent on digital devices was the greatest risk factor associated with the ocular symptoms. Although these ocular symptoms might be temporary, they can be frequent and persistent. A recent meta-analysis reported that the pooled prevalence of DES in 10.7% of the children.²⁴ In a study done at private schools of West India, reported 19.9% prevalence. The increased prevalence of DES in the current study might probably be due to increased visual demand of digital

devices because our study participants include children going online education.

Only 23.8% of the children in our study had a history of using the glasses during their online activities. And the majority of the children had not done eye examination till now. These findings suggest poor awareness among the children and parents regarding the eye examination even in the capital city of our country. Limiting the screen time is the best approach to reduce the ocular symptoms. Now, after the initiation of physical classroom by most of the academic institutions we expect the ocular symptoms to be less.

Limitations of the present study include its reliance on a self-reported questionnaire, which provided very subjective results and might have been affected by biases of the participants, thereby limiting the reliability of the data. Participants may exaggerate their experiences of some of the symptoms. Although other studies demonstrated the types of refractive errors and type of correction affects the symptoms of the patient, the effect of refractive errors and the type of corrections used was not investigated in the study. Another limitation of our study was ocular evaluations. However, this study was conducted during the lockdown period, when the ocular examinations were not possible. The main goal was to investigate the impact of lockdown on the number of hours children spent on digital devices and their experiences of the ocular symptoms. Also, prior studies have suggested that subject's self-assessment of vision status doesn't differ systematically from professional ophthalmic evaluations.²⁵ The results of the study highlight the importance of increasing the awareness of ocular effects on children with the use of digital devices. With the advent in science and progression in technology, digital devices use is predicted to increase in the coming future. Therefore, it is high time for every eye care professional to educate the public about the hazards of device use on ocular health and the steps they can initiate to at least minimize the effects.

CONCLUSIONS

Due to the COVID-19 pandemic, in Nepal, the teaching mode was transferred from school to family and offline to online. Our study highlights the increase in use of digital devices after the initiation of the COVID-19 lockdown and the effect of e-learning teaching model on children's ocular health. Moreover, educational campaigns on this subject matter should also be implemented as soon as possible with a focus on the importance of avoiding spending much time on computer monitors and handheld digital devices in order to preserve ocular health.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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