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The Effect of the E-Learning Teaching Model on Ocular Health during the COVID -19 Pandemic: a Cross-Sectional Questionnaire based Study on School Children

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Abstract: ***Context: The mandatory e-learning has emerged as a method for current teaching and learning in universities and schools with the COVID-19 pandemic. This calls for introspection into the potential deleterious health disorders resulting due to increased "screen time" in school going children. Aim: The aim of this study was to evaluate the occurrence of symptoms of computer vision syndrome (CVS) in young students due to prolonged screen time. Settings and design: Cross-sectional, questionnaire-based study conducted five months after the initiation of lockdown in India in school going children attending five schools of a metropolitan city in Eastern India. Subjects and methods: Pre-structured and pre-validated questionnaire was given as an online survey form in the social media school groups. Questions regarding hours of daily online classes, gadget used, whether any symptoms of eye strain occurred after or during online classes were asked. We also delved into the issue of any eye-comfort seeking behavior, any new use of spectacles, changes in spectacle power or visit to the ophthalmologist. Statistical analysis: Association between hours of online class and symptoms of eye strain, new use of spectacles or recent change in spectacle power by Spearman's rank correlation coefficient. Results: The mean duration of screen time was 4.54±4.45 hours per day. 80.4% rely on small screens of mobile phones to avail online classes. 15% needed spectacles due to progressive blurred vision and 23.3% recorded changes in the power of their spectacles during lockdown. There was a positive correlation between the hours of screen time and the development of symptoms of eye strain especially neck pain or stiffness (rho = 0.279), headache (rho=0.0.270), backache (rho=0.264), blurred vision (rho=0.216), shoulder pain (rho=0.203), redness of eyes with tears (rho=0.162), pain in the eyes (rho=0.140), new spectacle use or change of spectacle lens power during online classes (rho=0.661). Conclusions: The current study highlights the higher prevalence and positive correlation of CVS among school children exposed to long screen hours in the COVID pandemic. There is a need to educate people about limiting overall screen exposure and ergonomic methods of screen viewing.***

Keywords: COVID 19, e-learning, screen time, ocular health, computer vision syndrome, eye strain, school going children

1. Introduction

The COVID-19 pandemic has resulted in schools shutdown all across the world. Globally, over 1.2 billion children are out of their classroom. As a result, education has changed dramatically (1).The mandatory e-learning has emerged as a method for current teaching and learning in universities and schools with the COVID-19 pandemic.[2] This calls for introspection into the potential deleterious health disorders resulting due to increased "screen time" in school going children. (3)Computer vision syndrome (CVS) is characterized by a constellation of ocular and extraocular symptoms, basically range of eye and vision-related symptoms in computer users who are either habitually or on compulsion using computers for a prolonged time and has been recognized health problem for over 20 years (4, 5, 6).Without any specific guidelines, it is now a usual routine for our children to spend most of the time (8–12 h per day) attending e-classes in front of a computer or mobile screens. The terms visual fatigue (VF) and digital eye strain (DES) are also become a concerned matter , reflecting the digital devices linked to potential problems as these devices more frequently emit high energy waves that can penetrate eyes and can eventually contribute to photochemical damage to the retinal cells, making the exposed individual vulnerable to a variety of eye problems ranging from dry eye to age-related macular degeneration.[7,8] The most common symptoms associated with DES are eyestrain, headaches, blurred vision, dry eyes and pain in the neck and shoulders External symptoms of burning, irritation, tearing and dryness are noted to be closely related to dry eye, while

internal symptoms of strain, ache and headache behind the eyes are also seen(9) Prolonged reading on the mobile screen and watching it from close range may result in this type of problems.(10)According to medical professionals, since the declaration of the lockdown due to COVID-19, the usage of digital devices has gone up across the globe, resulting in a challenge for the visual systems of all ages, specially in youth and children.(11) Additionally this leads to neck stiffness, backache, myalgia, generalized body pain, mental fatigue in kids. With the sudden halt to in-person learning, many students are missing their friends, yearning to be out of the house, developing erratic sleep habits. (12)

CVS is commonly managed by non-pharmacologically and pharmacologically; non-pharmacological management includes correct ergonomic practices, maintaining normal blinking, the use of appropriate lighting, careful positioning of the digital device, adjusting image parameters (resolution, text size, contrast, luminance), and taking breaks, while pharmacological management strategies include using artificial tearsPrevention remains the mainstay in managing of CVS. Reasonable knowledge gives understanding, and understanding the disease gives the key to implement early preventive measures and treatment initiation. (13) The problem at hand is really grave wherein online portals are the only means to transmit education and there isn't much school authorities can do without its prolonged and daily use in making pupils learn. However at the same time this is causing increasing inclination to develop eyesight problems and decline of physical and overall well-being in school children.

The aim of this study conducted amidst school-going children in a metro city in Eastern India was to evaluate ophthalmological health status in young students as they are compelled to attend online classes and stare at computer screens for long due to stoppage of offline classes and transference of all learning to online modes in this pandemic.

2. Materials and Methods

This was a cross-sectional, questionnaire-based study conducted five months after the initiation of lockdown in India between September 2020 and February, 2021. The questionnaire was used to record the opinion of participants' to check for occurrence of symptoms of Computer Vision Syndrome. Institutional Ethics Committee permission was taken prior to conduct the study.

We have undertaken the study utilizing a self-administered questionnaire including relevant questions that was circulated to school going children of different classes enrolled from 5 schools of a metropolitan city of eastern India. The questionnaire underwent face and construct validation by two ophthalmologists unrelated to the study. Quantitative inter-rater validation was done by piloting 32 students. Correlation was done between answers given by the same set of 32 students at an interval of 5 days. The intraclass coefficient or kappa coefficient was very high (>0.9) for all items indicating that the questionnaire was sufficiently valid and reliable for our purpose. All consenting students from class 1 to 12 were included. The questionnaire was developed as an online electronic Google survey form. The questionnaire contained questions relating to the hours of daily online classes, the gadget used, whether any redness, tearing, headache, pain or difficulty in vision, neck stiffness, backache, shoulder pain, sleep disturbances occurred after or during online classes. Questions regarding any comfort seeking behavior like applying eye drop or eye pad application was also asked. We also delved into the issue of any new use of spectacles, change of power or visit to the ophthalmologist during lockdown period. The questions were framed using the pre-validated computer vision syndrome questionnaire designed by Segui et al. [12].

The survey was circulated as a Google link among social media groups of parents and was open to responses for one week. Questions were sent to 410 students, 240 students responded inturn satisfying the sample size. The form and its purpose were explained to their parents by respective class teachers. The children and parents who were willing to take part in the study then filled up the form with the help of their parents. Students suffering from any eye diseases (excepting myopia, hyperopia and previous spectacle use)and non-consenting students/ parents were excluded. Only completed questionnaires were considered for the study. Their filled up responses were analyzed after submission.

Sample Size and statistical analysis:

Formal sample size was calculated by the following formula:

$n=N\ x\ /\ ((N-1)\ E^2+x)$ where n=sample size being calculated, N is the population size, E is the margin of error and $x=Z(c/100)^2\ r(100-r)$ where Z (c/100) is the critical value for the confidence level c and r is the fraction of responses the investigator is interested in. Taking N=1000, E=5.52%, c=95, r=50% the sample size is n=240 using the formula above. [16] Each parameter of the questionnaire was represented as the number and percentages of the total respondents. Correlation was done between hours of online class and various symptoms of eye strain, new usage of spectacles or change in spectacle lens power, and visit to the ophthalmologist by Spearman's rank correlation coefficient (rho). MedCalc version 10.2 (MedCalc Software, 2011, Mariakerke, Belgium) was used for statistical analysis. The cutoff for statistical significance was $P < 0.05$.

3. Results

The responder rate of the questionnaire was 58.54%. The age distribution of the respondents showed that all the respondents (100%) were currently attending online classes. Of these, 56.7% were being taught online exclusively by school whereas 43.2% had other sources like tuitions and other sources (learning apps).

Sources conducting online classes the respondent is attending showed that 43.3% of the respondents attended online classes for 2 to less than 4 hours whilst 21.7% had quite long durations of 6 to almost 12 hours as a duration spent in online study. The mean duration of screen time was 4.54±4.45 hours (95% CI= 3.99 to 5.08) per day.

In case of gadget uses we found a large portion i.e. 80.4% rely on small screens of mobile phones to avail online classes while additionally using laptops and some other sources (like tablets) as well.

33.3% of respondents did have spectacles priorly. Among the rest, 15% needed spectacles due to progressive blurred vision after attending online classes in lockdown. (Table 1)

Almost a half of the respondents had developed redness in the eyes from mild to severe degree after attending online classes. 5% felt they had severe redness.67.6% had headache of varying severity with 17% complaining of severe headache. More than half of the respondents felt there vision is blurred and they experienced some difficulty in seeing in lieu of attending online classes for long. Also more than half complained of repeated blinking and difficulty in straight vision52.3% respondents complained of pain and burning in eyes with 8.3% complaining of severe pain. Other than direct eye related symptoms, opinion regarding other health issues showed that more than half the respondents had pain, rigidity soreness in their shoulders, neck and back after long online classes. 51% had sleep disturbances also with 15.3% having prominent problems in sleep. (Table 2)

The students consulted an ophthalmologist due to increased eye problems in around 36.6% cases. 23.3% recorded changes in the power of their spectacles during lockdown. Around 95% of respondents resorted to some measures to alleviate eye symptoms whilst attending online classes be it splashing water, applying warm or cool eye packs, or applying eye drops, taking breaks or using doctor specified eyewear. A whopping 80.5% respondent confessed they preferred offline classes. (Table 3)

There was a positive correlation between the hours of screen time and the development of symptoms of eye strain especially neck pain or stiffness (rho = 0.279), headache (rho=0.0.270), backache (rho=0.264), blurred vision/ difficulty in seeing / not able to see straight /repeat eye blinking (rho=0.216), shoulder pain (rho=0.203), redness of eyes with tears (rho=0.162), pain in the eyes/ burning sensation in the eyes (rho=0.140). The prolonged screen time also showed a highly positive correlation with new spectacle use or change of spectacle lens power during online classes (rho=0.661, p=0.0002, 95% CI= 0.375 to 0.832). The students visited ophthalmologist during their online classes and the visit was positively correlated with the hours of online class (rho=0.152). However, sleep disturbances did not correlate (rho=0.095) with hours of online class. (Table 4)

4. Discussion

Due to the current COVID situation, schools have become virtual, and online teaching is the only mode of conducting classes in the school children estranged from school, friends and teachers. In our study, we have found that all school going children attended some or the other form of virtual classes from their homes keeping abreast with their curriculum, giving online formative and summative examinations. 80.5% of the respondents agreed that they preferred online classes as it was the only mode of communication, education and maybe meeting and greeting friends and teachers in these challenging pandemic situation. A similar European study by Palaiologou I, reported that 68% of children regularly used computers and 54% undertook online activities.[17] The current trend of online classes has fuelled online teaching apps, even tution classes and extracurricular activities are being conducted by the virtual mode.

However, the spurt of online classes and the increased screen time are not without health hazards. Initially children who were confined by an hour per day norm of screen viewing are now experiencing an average of 4.5 hours. Our study has found that this exponential rate of increased screen viewing has drawn in multitude of eye strain problems like neck pain or stiffness, headache, backache, blurred vision/ difficulty in seeing / not able to see straight /repeat eye blinking, shoulder pain, redness of eyes with tears and pain in the eyes/ burning sensation in the eyes. Also, the increased hours of screen time resulted in a significantly large number of students developing change of power of spectacle lens, new use of spectacles. Mohan A et al has showed the there is an increased prevalence of digital eye strain (DES) among children in COVID era.(18) Another cross-sectional study by Ganne P et al, conducted to estimate the digital eye strain showed the prevalence of eye strain was higher among students taking online classes compared to the general public (50.6% vs 33.2%, $p < .0001$). The DES score was highest among students attending online classes ($p < .0001$), in those with eye diseases ($p = .001$), greater screen time ($p = <0.0001$), screen distance <20 cm ($p = .002$), those who used gadgets in dark ($p = .017$) and those who took infrequent/no breaks ($p = .018$) [19]. Our study findings were similar to the aforementioned study in that increased screen time was positively correlated with development of DES. Another study conducted during lock down in South India highlighted the drastic increase in use of digital devices in all age groups after the initiation of the COVID-19 lockdown, and along with deterioration of ocular health (20).

This shows that increased screen time has resulted in eye strain, visual fatigue and CVS development. The school children had resorted to several methods to reduce eye starin like splashing water, applying cold or warm eye packs, taking intermittent breaks or napping in between classes or applying eye drops. Thus we find that DES is a reality that some children and guardian are aware of and they have undertaken various methods to reduce the eye strain. However, use of unprescribed eye drops by 14.2% chidren is a matter of concern. It would be advised that the guardians and children must be made aware that the indiscriminate use of eye drops can cause more harm than good. All schools could have an ophthalmologist on board to deal with this ever increasing problem of eye strain so that the children can have access to the best medical advice. Advisories regarding eye care can be circulated by the school in the social media groups for better eye care. In the best interest of children, imparting education must not pose any or minimal health hazard.

The limitations of our study were that this survey was circulated in parents' social media groups, we were unable to

identify whether the responders were parents/guardians of school-going children or the children themselves. Also, our study was designed on a symptom-based questionnaire that required responders to indicate the frequency and intensity of symptoms experienced during digital device use, which is a subjective feeling and varies individually, and may have some bias. Research in COVID times has been mainly conducted on the epidemiology, risk modelling, pathophysiology, and clinical features of severe acute respiratory syndrome in SARS CoV-2 (22,23) but the impact of increased digital screen time that caused by the lockdown and quarantine measures in many cities worldwide on eye strain has largely been unnoticed.(24)

5. Conclusion

The current study highlights the higher prevalence and positive correlation of DES among children in the present scenario with coronavirus disease 19 (COVID-19) pandemic and the deleterious effect of the e-learning teaching model on children's ocular health. Our findings highlight an important child ocular health issue in this era and make the parents, teachers, and eye care providers to be considerate about evidence-based measures to avoid complications in children. There is a need to educate people about limiting overall screen exposure and ergonomic methods of screen viewing.

6. Conflict of Interest

The authors certify that the study reported has not received any financial support from any pharmaceutical company or other commercial source. None of the authors or any first degree relative of the authors have any financial interest in the subject matter discussed. The study was purely academic in nature.

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Tables

Table 1: Baseline clinico-demographic characteristics of school students attending online classes

Parameter	No of respondents	Percentage
Age		
>=7 to <=10	46	19.2
>=11 to <=14	141	58.6
>=15 to <=18	53	22.2
Agency conducting online classes		
School only	136	56.7
School and other sources	104	43.3
Hours of online classes per day		
>=2 to <=4	104	43.3
>=4 to <=6	84	35
>=6 to <=12	52	21.7
Gadget used (taking into consideration each student uses multiple gadgets and not just a single type)		
Mobile phone	193	80.4
Laptop	124	51.7
Others	22	9.2
Usage of spectacles		
Got spectacles in lockdown	36	15
Had spectacles from before	80	33.3
No spectacles	124	51.7

Table 2: Frequency of appearance of Computer vision symptoms parameters in school going children attending online classes

Parameter	*Grading*	*Percentage Affected (%)*
Redness in the eyes	Absent	52.3
	Mild	33.6
	Moderate	9.1
	Severe	5.0
Headache	Absent	32.4
	Mild	29.5
	Moderate	20.7
	Severe	17.0
Blurred vision with difficulty in seeing.	Absent	49.8
	Mild	24.5
	Moderate	17.8
	Severe	7.9
Pain/burning sensation in the eyes	Absent	47.7
	Mild	29.0
	Moderate	14.9
	Severe	8.3
Repeated eye blinking and cannot see straight.	Absent	49.6
	Mild	25.0
	Moderate	17.1
	Severe	8.3
Neck pain/stiffness	Absent	36.9
	Mild	21.6
	Moderate	23.2
	Severe	18.3
Backache	Absent	39.8
	Mild	26.6
	Moderate	19.9
	Severe	13.7
Shoulder pain	Absent	45.2
	Mild	27.8
	Moderate	16.2
	Severe	10.8
Sleep disturbances	Absent	49.0
	Mild	22.4
	Moderate	13.3
	Severe	15.3

Table 3: Measures taken by school going children attending online classes

Parameter	No of respondents	Percentage
Consultation of an ophthalmologist after onset of online classes		
Yes	88	36.6
No	152	63.3
Change of eye power during lockdown		
Yes	56	23.3
No	60	25.0
Not applicable	124	51.7
Any protective step undertaken to care for eyes (multiple methods)		
Splashing cold/normal water or applying ice pack to eyes	31	12.9
Applying warm pad	11	4.6
Taking intermittent breaks during classes or napping after classes	10	4.2
Applying eye drops	34	14.2
Using special protective eye-ware as suggested by doctor	2	0.8
Other precautionary steps	3	1.3
Nil	15	6.2
Preference of classes		
Online classroom education	194	80.5
Offline/ Contact classes	46	19.5

Table 4: Correlation of hours of online class with various symptoms of eye strain

Parameter	Spearman's Correlation coefficient (rho)	P value	95% confidence interval
Redness of eyes with tears	0.162	0.015	0.032 to 0.286
Headache	0.270	<0.0001	0.144 to 0.386
Blurred vision/ Difficulty in seeing / Not able to see straight /Repeated eye blinking	0.216	0.0007	0.093 to 0.332
Pain in the eyes/ burning sensation in the eyes	0.140	0.035	0.010 to 0.266
Neck pain or stiffness	0.279	<0.0001	0.155 to 0.395
Backache	0.264	0.0001	0.139 to 0.381
Shoulder pain	0.203	0.002	0.075 to 0.325
Sleep disturbances	0.095	0.154	-0.036 to 0.222
New spectacle use or change of power of spectacle lens after attending online classes	0.661	0.0002	0.375 to 0.832
Visit to ophthalmologist during attending online classes	0.152	0.013	0.023 to 0.231