DIGITAL EYE STRAIN AMONG UNDERGRADUATE MEDICAL STUDENTS OF NEPAL MEDICAL COLLEGE AND TEACHING HOSPITAL DURING COVID-19 PANDEMIC

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ABSTRACT

During Covid-19 Pandemic, there was declaration of lockdown which led to increased usage of digital devices due to starting of online classes. Increased duration of digital device usage predisposed students to Digital eye strain (DES). This study aimed at estimation of the prevalence of DES among medical students of Nepal Medical College and Teaching Hospital during Covid pandemic. It also analyzed the pattern of digital device usage, risk factors for DES, awareness and practice of preventive measures taken by students during online classes. This was a cross-sectional questionnaire-based survey which included one hundred and sixteen undergraduate medical students. The mean age of the students was 22±1.30 years. Sixty-two students (53.4%) were male and fifty-four (46.6%) were female. There was a significant increase in the duration of digital device usage during Covid -period as compared to pre-Covid period (P=<0.001). The prevalence of the DES was 68.1% of which 60.34% had mild DES and 7.76% had moderate DES. The most common ocular symptoms were burning sensation (69.8%) followed by eyesight worsening (60.3%) and eyepain (56%). This study didn't find significant association between DES and its risk factors like duration of digital device usage, distance from screen, posture, frequency of break and level of screen during online classes. Preventive measures like uses of lubricating eyedrop and use of anti-reflective coated glasses/ blue ray cut glasses were significantly associated with less frequency of DES (P=0.03,0.01 respectively). DES is an emerging eye health problem due to increase screentime exposure, so limitation of screentime and practice of 20-20-20 rule is recommended to reduce DES related symptoms.

KEYWORDS

Digital eyestrain, Computer vision syndrome, Digital devices, 20-20-20 rule, Covid-19

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INTRODUCTION

The World Health Organization (WHO) declared outbreak of COVID -19 as a Global Pandemic on March 11, 2020.[1] This Global pandemic affected almost all the aspects of life. "Social distancing" was one of the recommended practice during this pandemic. Nepal government also imposed nationwide strict lockdown during Covid–19 pandemic. Public places, school and educational institutions were closed during this period.

Educational institutes adopted e-learning as an alternative method of teaching-learning activities during Covid-period. Even mode of communication, interaction, recreational activities like online gaming, blogging, social networking became digitalized during this period. The use of video display terminals (VDTs), such as computers, laptops, tablets, smartphones, e-readers, and other digital devices, became an important part of human life during Covid- pandemic. There was rapid increase in digitalization during Covid-pandemic, due to which there was increased time spent in front of VDTs. Increased and prolonged use of VDTs predisposed the young generation to a variety of health issues limited not only to visual problems but also including various musculoskeletal problems, collectively known as digital eye strain (DES) or computer vision syndrome.[2]

Computer vision syndrome (CVS) is defined as a complex of eye and vision problems resulting from the activities, which stress the near vision during the use of the computers and digital screen. The term DES is also used for this condition.[3] DES is usually related to watching the computers or digital screens that make the near work of the eye more difficult. The high visual requirements and visual attention makes any computer user susceptible for developing DES.[3] The main symptoms of the DES are eyestrain, headache, dry eye sensation, blurred vision, tearing, burning of the eyes, watering of the eyes, photophobia, red eyes, burning, itching, neck and shoulder pain, and contact lens trouble.[4,5]

Various reports published during Covid pandemic had reported increased incidence of digital eye strain among students due to long hours of online classes.[6-8] Hence, this study was carried out to determine the prevalence of DES, frequency of digital eyestrain symptoms and its associated risk factors among undergraduate medical students of Nepal Medical College and Teaching Hospital, who were attending online classes during COVID- 19 pandemic. The awareness and practice of preventive measures by undergraduate students was also analyzed in our study.

MATERIAL AND METHODS

This was a questionnaire based cross-sectional descriptive study. A total of 120 students were enrolled for this study by non- probability convenience sampling technique. The study was conducted after receiving ethical clearance from Institutional Review Committee of Nepal Medical College and Teaching Hospital (Ref:016-078/079). This study was conducted over a period of 6months from July 2021to Dec 2021.

The self-administered questionnaire was sent in google form to all the students (120 students) studying in third year MBBS, who were attending online classes during Covid-pandemic. The questionnaire comprised of demography of the students, information on pattern and duration of digital device usage, digital eye strain symptoms questionnaire and knowledge and practice of preventive measures during digital device usage.

Before questionnaire, introduction on the purpose of the study was given to the students. Brief instructions were given to the students before filling the questionnaire form. Anonymity and confidentiality of the data provided were maintained during study. The students were allowed to withdraw from the study if they were not willing to participate.

The DES symptoms and its severity were measured using Computer vision syndrome questionnaire (CVS-Q) developed by Sengui *et al.*[9] The CVS-Q evaluated the intensity (moderate or intense) and frequency (never, occasionally, or always /often) of 16 eye strain related symptoms, including burning sensation, itching in the eyes, foreign body sensation, watering, excessive blinking, redness, eye pain, heaviness in the eyelids, dryness, blurring of vision, double vision, difficulty in near vision, intolerance to light, colored halos, worsening of vision and headache. Frequency was recorded as follows; NEVER = symptoms didn't occur at all, OCCASIONALLY= sporadic symptoms or once a week, often or always= 2-3 times in a week or almost daily. Intensity was recorded as moderate or severe. The total score was calculated applying the following formula

$$\text{Score} = \sum_{i=1}^{16} (\text{Frequency of symptoms occurance x intensity of symptoms});$$

Where,

Frequency: Never=0, occasionally=1, often or always =2
Intensity: moderate =1, intense=2

The overall assessment was conducted by obtaining total score, recorded as the DES score. The result of frequency x intensity was recorded as: 0= 0; 1or 2= 1; 4=2. If the total score was ≥6 points, the students were considered to be suffering from digital eye strain. DES scores were further categorized as mild (DES score=6-12), moderate (DES score= 13-18) and severe (DES score = 19-32)

All the data collected from the respondents were exported as Microsoft Excel sheets and statistical analysis was performed using IBM SPSS 23 Statistical software. Chi – square test was used to analyze the association between different variables. A P value <0.05 was considered statistically significant.

RESULTS

Out of a total of 120 third year MBBS students; 116 students (80%) who submitted the completely filled questionnaire were included in this study. Among 116 students, 62(53.4%) were male and 54(46.6%) were female. The age of the students ranged from 20 to 29 years with the mean age being 22±1.30 years. One hundred and seven students (n=107,92.24%) were attending online classes for more than two hours daily. Most of the students (n=72,62.1%) used single device for online classes. The most preferred device for online classes was laptop (n=57,49.1%), followed by smart phone (n=50,43.1%) and iPad /tablet (n=9,7.8%). Ninety-one students (n=91,78.4%) spent > 5 hrs. daily in digital device during covid period. Before covid period only 31% (n=36) students used to spend > 5hr in digital device whereas 69% (n=80) used to spent <5hr on digital device. The difference in total duration of digital device usage before and during covid period was statistically significant using Pearson chi square test (p= <0.001).

Most of the students (n=96, 82.75%) played mobile games using smart phone during Covid time. Among them 56.9% (n=66) played mobile games for < 1 hr. and 25.86% (n=30) played for > 1hr. Only thirty-four of our students (n=34, 29.4%) watched television during covid period, whereas 70.6% (n=82) students didn't spend time watching television during covid time. Among the students who watched television, 17(14.7%) of the students watched television for < 1 hour, 14 (12.1%) watched for 1-2 hr. and 3(2.6%) watched for >2 hr.

To assess the risk factors for developing Digital eye strain, students were asked about the distance at which the digital device was kept during online classes. While using laptop, most of the students kept laptop at the distance > forearm length (n=69,59.5%). Only 40.5% (n=47) kept laptop at the distance < forearm length. While using smartphone/mobile, 58.6%(n=68) of students kept them at the distance of 12-16 inches. 34.5%(n=40) kept them at < 12 inches and 6.9%(n=8) kept them at >16 inches.

The posture adopted during online classes were both lying and sitting by 56(48.3%) students. Forty-one (35.3%) students used sitting position during online classes whereas nineteen (16.4%) students were lying during online classes. The level of computer screen was kept at the eye level by 57(49.1%) students, 56(48.3%) students kept below the eye level and 3 (2.6%) students kept above the eye level. Fifty- nine students (n=59, 50.9%) used to take interval at less than 1 hour while 49.1%(n=57) of them took interval at more than 1 hour duration.

Questions on preventive measures for DES were asked to students. The most commonly practiced preventive measure was taking break in between computer usage (n=109,94%). The second commonly practiced preventive measure was adjustment of brightness and glare of the computer screen during digital device usage (n=92, 79.3%). The students were asked if they voluntarily blink during prolong use of digital device, 52 (44.8%) students responded yes, 35(30.2%) students responded no and 29 (25%) students responded maybe. Forty-four students (n=44, 37.9%) students practiced looking at the far object during break while more students (n=71, 61.2%) didn't practice this maneuver and one student (0.9%) didn't know about this. Thirty-seven (31.9%) students used radiation filter on screen while using laptop/computer, 64 (55.2%) didn't use it and 15 students (12.9%) didn't know about it. Forty - eight students (41.4%) used either anti reflecting coated or blue ray cut glasses during online classes, while 58(50%) of them didn't use and ten students (8.6%) didn't know about this. Some of the students (n=23,19.8%) used lubricating eye-drop to relieve the computer vision syndrome symptoms, 93 (80.2%) didn't use any lubricating eye-drop.

To assess the knowledge of digital eye strain/ computer vision syndrome, we asked students whether they knew if digital device has bad effect on eye. 94.8%(n=110) students responded yes and 5.2% (n=6) responded no. Only 29.3% (n=34) students have heard about 20-20-20 rule to prevent computer vision syndrome while 70.7% (n=82) students haven't heard of 20-20-20 rule. Twenty-one students (18.1%) practice

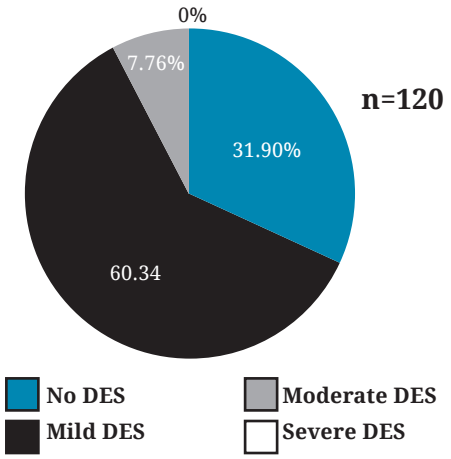

Fig. 1: Prevalence of Digital eye strain

20-20-20 rule while 95 (81.9%) didn't practice the rule.

On the basis of the frequency and the intensity of the symptoms present during online classes the DES score was calculated. The students were considered to have DES if the total score was ≥6. In our study the prevalence of DES was 68.1% (n=79). The DES was graded as mild, moderate or severe depending on the points scored. Most of our students had mild grade of DES (n=70, 60.34%), only nine students (7.76%) had moderate DES as shown in Fig. 1. None of our students had severe DES.

The most common ocular symptoms experienced by students was burning

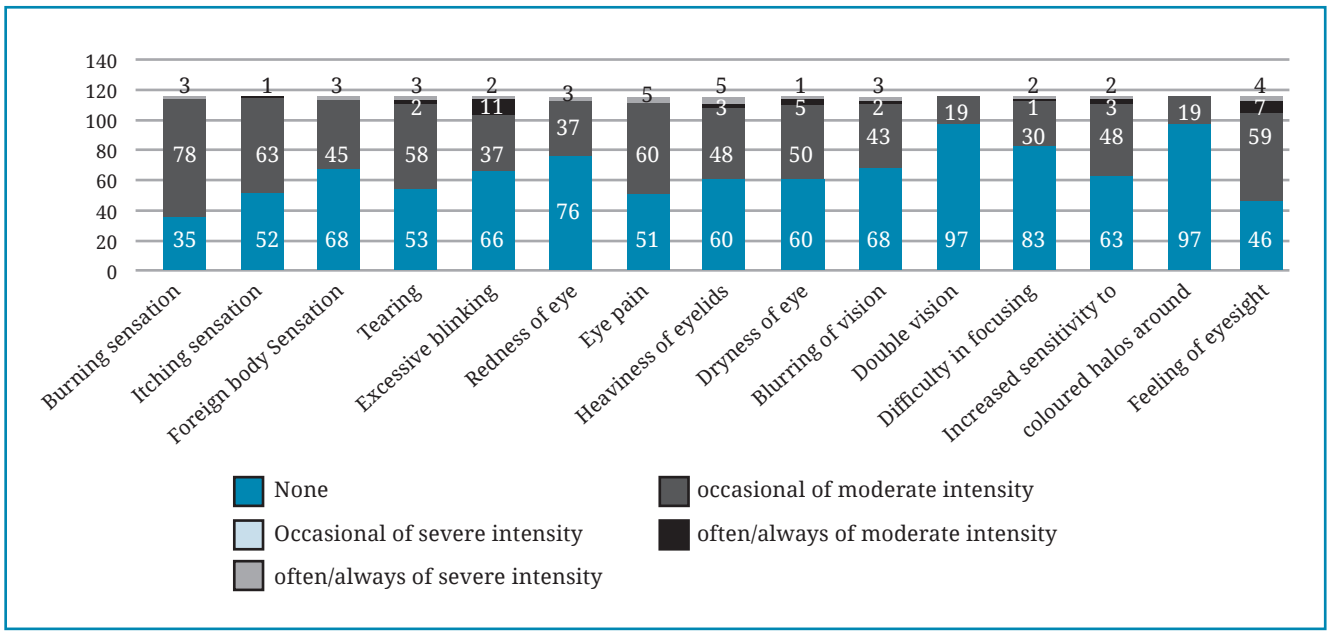

Fig. 2: Frequency and intensity of Digital eyestrain symptoms (n=120)

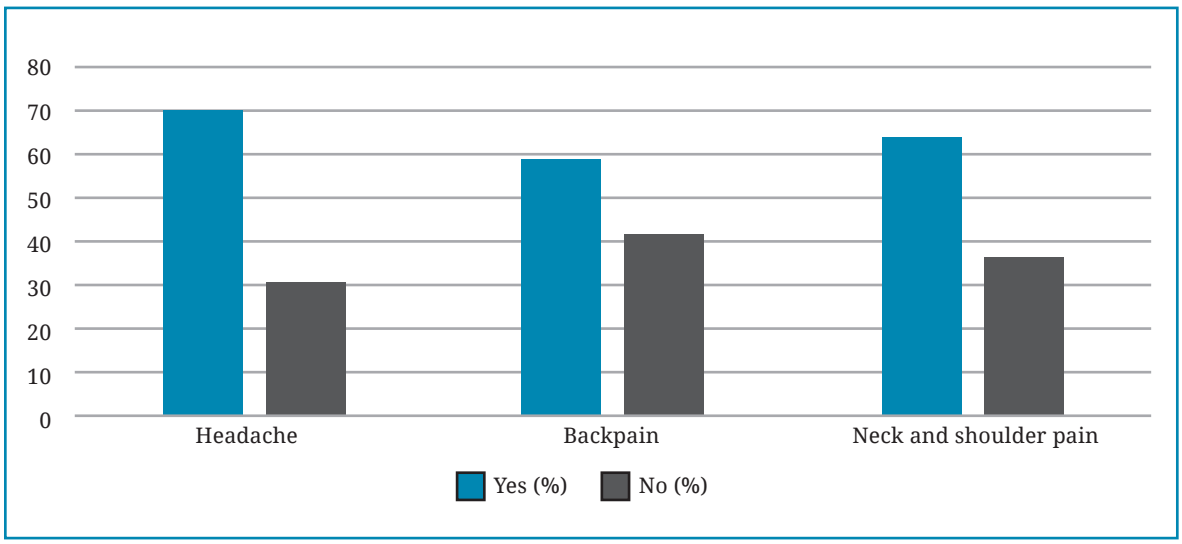

Fig. 3: Extraocular symptoms of Digital eyestrain (n=120)

sensation(n=81,69.8%), followed by feeling of eyesight worsening (n=70,60.3%) and eye pain (n=65,56%). The least experienced symptoms were doubling of vision(n=19,16.4%) and halos around the object (n=19,16.4%). The frequency and intensity of different digital eye strain symptoms are shown in the Fig. 2.

The most common extraocular symptom experienced by students was headache (n=81,69.8%) followed by neck and shoulder pain (n=74,63.8%) as shown in figure 3.

In our study, duration of digital device usage was not significantly associated with presence of DES (table 1). Duration of digital device usage was also not significantly with common eye symptoms and extraocular symptoms of DES (table 3).

Table 1: Association of digital device usage pattern and its risk factors with Digital eyestrain.

Variables	Groups	DES		P value
		Yes n (%)	No n (%)	
Duration of Digital device usage	< 5hr	15 (18.98%)	10 (27.03%)	0.32
	> 5hr	64 (81.02%)	27 (72.97%)	
Digital device used for online classes	Laptop	42 (53.16%)	15 (40.54%)	0.25
	Mobile	30 (37.97%)	20 (54.05%)	
	Tablet/ i-pad	7 (8.86%)	2 (5.41%)	
Distance from laptop/ desktop	< forearm length	32 (40.51%)	15 (40.54%)	0.99
	> forearm length	47 (59.49%)	22 (59.46%)	
Distance from mobile phone	< 12 inches	30 (37.97%)	10 (27.03%)	0.50
	12-16 inches	44 (55.70%)	24 (64.86%)	
	> 16 inches	5 (6.33%)	3 (8.11%)	
Frequency of taking breaks	< 1hr	43 (54.43%)	16 (43.24%)	0.26
	> 1hr	36 (45.57%)	21 (56.76%)	
Posture	Mostly lying	9 (11.39%)	10 (27.03%)	0.08
	Mostly sitting	28 (35.44%)	13 (35.13%)	
	Both	42 (53.16%)	14 (37.84%)	
Level of the screen	At eye level	40 (50.63%)	17 (45.95%)	0.41
	Above eye level	1 (1.27%)	2 (5.40%)	
	Below eye level	38 (48.10%)	18 (48.65%)	

Table 2: Association of preventive measures taken by students with digital eyestrain

Variables	Groups	Digital Eye Strain		P value
		Yes n (%)	No n (%)	
Taking breaks	Yes	73 (92.41%)	36 (97.30%)	0.30
	No	6 (7.59%)	1 (2.70%)	
Adjustment of screen brightness	Yes	65 (82.28%)	27 (72.97%)	0.33
	No	13 (16.45%)	10 (27.03%)	
	I don't know	1 (1.27%)		
Voluntarily blinking of eye	Yes	36 (45.57%)	16 (43.24%)	0.16
	No	20 (25.32%)	15 (40.54%)	
	May be	23 (29.11%)	6 (16.22%)	
Use of ARC/ blue ray cut glasses	Yes	39 (49.37%)	9 (24.32%)	0.01*
	No	40 (50.63%)	28 (75.68%)	
Use of radiation filter	Yes	27 (34.18%)	10 (27.02%)	0.64
	No	43 (54.43%)	21 (56.76%)	
	I don't know	9 (11.39%)	6 (16.22%)	
Use of lubricating eye drop	Yes	20 (25.32%)	3 (8.11%)	0.03*
	No	59 (74.68%)	34 (91.89%)	

In regard to the pattern of the digital device usage; types of the device used for the online classes, distance from the laptop, distance from the mobile phone, posture of the students during classes, frequency of break during online classes, level of the computer screen was not significantly associated with the presence of DES (table 1).

Most commonly practiced preventive measures by our students, as shown in table 2, like taking breaks during online classes, adjustment of screen brightness, voluntary blinking of the eyes and use of radiation filter in screen was not significantly associated with DES. But uses of ARC/ Blue ray cut glasses and lubricating eye drop during online classes was significantly associated with less frequency of digital eye strain (P=0.01,0.03 respectively)

In our study, we didn't find any significant association between duration of digital device usage and common ocular and extraocular symptoms of digital eye strain. Distance from laptop and mobile, posture during online classes was also not significantly associated

Table 3: Association of duration and pattern of digital device usage with common ocular and extraocular symptoms of DES

Variable	Group	Burning sensation (n=81)	P value	Eye sight worsening (n=70)	P value	Eye pain (n=65)	P value	Headache (n=81)	P value	Neck & shoulder pain (n=74)	P value
Duration	< 5hr	17(20.99%)	0.82	16(22.86%)	0.67	15(23.08%)	0.65	18(22.22%)	0.78	15(20.27%)	0.65
	> 5hr	64(79.01%)		54(77.14%)		50(76.92%)		63(77.78%)		59(79.73%)	
Distance from laptop	<forearm	35(43.21%)	0.36	34(48.57%)	0.02*	27(41.54%)	0.80	30(37.04%)	0.24	31(41.89%)	0.68
	>forearm	46(56.79%)		36(51.43%)		38(58.46%)		51(62.96%)		43(58.11%)	
Distance from mobile	< 12 inches	32(39.51%)	0.21	27(38.57%)	0.48	24(36.93%)	0.53	31(38.27%)	0.35	28(37.84%)	0.14
	12-16 inches	43(53.08%)		39(55.71%)		37(56.92%)		44(54.32%)		39(52.70%)	
	>16 inches	6 (7.41%)		4(5.71%)		4(6.15%)		6(7.41%)		7(9.46%)	
Posture	Mostly lying	11(13.58%)	0.36	7(10%)	0.06	8(12.31%)	0.20	10(12.34%	0.20	12(16.22%)	0.08
	Mostly sitting	28(34.57%)		28(40%)		20(30.77%)		30(37.04%)		21(28.38%)	
	Both	42(51.85%)		35(50%)		37(56.92%)		41(50.62%)		41(55.40%)	
Level of screen	Eye level	39(48.15%)	0.32	34(48.57%)	0.08	36(55.38%)	0.06	42(51.85%)	0.02*	31(41.89%)	0.04*
	Above eye level	1(1.23%)		0(0%)		0(0%)		0(0%)		1(1.35%)	
	Below eye level	41(50.62%)		36(51.43%)		29(44.62%)		39(48.15%)		42(56.76%)	

Table 4: Association between preventive measures and common ocular and extraocular symptoms

Variable	Group	Burning sensation n=81	P value	Eye sight worsening n=70	P value	Eye pain n=65	P value	Headache n=81	P value	Neck & shoulder pain n=74	P value
Frequency of break	< 1hr	43(53.09%)	0.68	35(50%)	0.81	35(53.85%)	0.46	42(51.85%)	0.74	38(51.35%)	0.88
	> 1hr	38(46.91%)		35(50%)		30(46.15%)		39(48.15%)		36(48.65%)	
Adjustment of screen brightness	Yes	68(83.95%)	0.13	57(81.43%)	0.49	51(78.46%)	0.67	67(82.72%)	0.25	61(82.43%)	0.33
	No	13(16.05%)		13(18.57%)		14(21.54%)		14(17.28%)		13(17.57%)	
Voluntarily blinking of eyes	Yes	35(43.21%)	0.31	30(42.86%)	0.12	30(46.15%)	0.26	39(48.15%)	0.14	33(44.60%)	0.95
	No	24(29.63%)		18(25.71%)		16(24.62%)		20(24.69%)		23(31.08%)	
	May be	22(27.16%)		22(31.43%)		19(29.23%)		22(27.16%)		18(24.32%)	
Use of ARC/ Blue-ray cut glasses	Yes	39(48.15%)	0.02*	34(48.57%)	0.10	32(49.23%)	0.11	34(41.98%)	0.77	38(51.35%)	0.01*
	No	42(51.85%)		36(51.43%)		33(50.77%)		47(58.02%)		36(48.65%)	

with common ocular and extraocular symptoms of DES but there was significant association between distance from laptop and eyesight worsening (P=0.02). Level of screen was significantly associated with headache and neck and shoulder pain (P=0.02, 0.04 respectively) but not with other ocular symptoms of DES; detail shown in table 3.

Table 4 shows, preventive measures like frequency of breaks during online classes, adjustment of screen brightness, voluntarily blinking of eyes was not significantly associated with common ocular and extraocular symptoms of DES in this study. Whereas, use of ARC / blue ray cut glasses was significantly associated with less frequency of burning sensation and neck and shoulder pain (P=0.02,0.01 respectively)

DISCUSSION

Globally, Digital eye strain is an emerging eye health problem due to the increase use of computer/digital devices among the present generation. There was an increase in usage of digital devices largely as a result of starting of online classes in educational institutes globally during Covid-19 pandemic. Nepal Medical College and Teaching Hospital also started online classes for all its students during that time, hence all 3rd year MBBS students who were attending online classes were included in our study.

Majority of our students (n=91, 78.4%) spent >5 hours on digital device during Covid- pandemic. There was significant increase in duration of digital device compared to pre-covid period (p=<0.0001). In pre-covid era, 36 students (31.0%) used to spend more than 5 hours while 80 students (69.0%) used to spend less than 5 hours on digital devices. This was similar to study done by Mohan *et al*[10] who reported significant increase in duration of digital device usage during COVID era as compared to pre-covid era (P=<0.0001). In his study, 36.9% children were using digital devices for > 5hr in the COVID era as compared to 1.8% of children before the COVID era. Other studies by Ganne *et al*,[11] Bahkir *et al*[12], Johnson V. Babu *et al*,[6] Balsam Alabdulkader *et al*,[8] L Wang *et al*,[13] have also reported significant increase in duration of digital device usage during covid- period as compared to pre-covid period and average duration of digital device usage was more than 5 hours.

The prevalence of DES in our study during covid-pandemic was 68.1% (n=79). The DES was graded as mild, moderate or severe depending on the points scored. Most of our students had mild grade of DES (n=70, 60.34%), only nine students (7.76%) had moderate DES.

The prevalence of digital eye strain is estimated to range from 25% to 93%, as reported in various studies depending on the cohort of the population studied and methodology of the study.[14-18] Reddy *et al*[19] reported DES in 89.9% of students in their questionnaire –based study. In a study done by Wang *et al*[13] to compare the prevalence of computer vision syndrome among Chinese students and MBBS students were 50.79% and 74.32%, respectively (*P* = 0.004). Babu *et al*[6] conducted an epidemiological observational study, during lockdown period among people of Kerala with a structured and validated questionnaire using Google form. People with age ≥ 18 years, using digital screen on continuous basis were included in that study. A total of 584 participated in that study where more than 86% reported at least one symptom. Study by Nooren *et al*[7] has reported high prevalence of 98.7% during Covid period. However, in that study presence of any one symptom that lasted for at least one week was considered as presence of CVS. But in our study, students were considered to have DES only when total score is >6. A questionnaire based cross-sectional online survey conducted by Mohan *et al*[10] to assess prevalence and risk factor of digital eyestrain among children using online e-learning during the COVID -19 pandemic in higher secondary schools of Madhya Pradesh, India, found prevalence of DES to be 50.23%. In this study, 26.3% had mild grade, 12.9% had moderate grade and 11.1% had severe grade. Ganne *et al*[11] also conducted a cross sectional survey to estimate the prevalence of digital eyestrain, describe the pattern of gadget usage and analyze the risk factors of DES. In that study the prevalence of eyestrain was higher among students taking online classes compared to the general public (50.6% vs 33.2%; P < .0001).

In our study, most of the students (n=72,62.1%) used single device for online classes. The most preferred device for online classes was laptop (n=57, 49.1%), followed by smart phone (n=50, 43.1%) and iPad /tablet (n=9,7.8%). Another questionnaire-based survey to assess CVS among medical students in Sohag University, Egypt by Iqbal *et al*[20] also found laptop (73%) was the most frequent used devices followed by tablets/iPad notes (43%). Previous studies suggested that older age groups prefer using laptops and desktops to browse the internet, whereas younger adults/children are more likely to use smartphones for this purpose.[21,22]

Our study found that most of the students (n=96, 82.75%) played mobile games using

smart phone during covid time. Among them 56.9% (n=66) played mobile for < 1 hr. and 25.86% (n=30) played for > 1hr. In the study conducted by Alabdulkader *et al*[8] the devices most commonly used by the participants were smartphones (n=82, 100%), followed by computers (n=47, 57%) and televisions (n=29; 35%). Similarly, a study conducted by Mohan *et al*[10] reported that 55.3% of students from 6th to 8th standard, used smart phone for <1 hr to play mobile games and 18.4% used for 1-2 hr. This study found that the use of mobile games for >1 hr per day was a significant risk factor for DES among children in multivariate analysis (*P* = 0.0001). However, our study didn't find any significant association between duration of mobile game and Digital eye strain (P= 0.44). Moon *et al*[23] also reported that smartphone use was more commonly associated with dry eye disease (71%, *P* = 0.036) as compared to other digital devices in a case-control study among school going children. Continuous smartphone use leads to a decrease in the blink rate, causing dry eye-related problems. Smartphones are also used with a short viewing distance because of their small screens, thus causing more asthenopia symptoms. The prolonged and constant use of smartphone based video games in children may have an adverse effect on their visual system and cause DES.[24]

To assess the risk factors for developing Digital eye strain, students were asked about the distance at which the digital device was kept. While using laptop, most of the students kept laptop at the distance > forearm length (n=69, 59.5%). Only 40.5% (n=47) kept laptop at the distance < forearm. While using smartphone/ mobile 58.6% (n=68) of students kept them at the distance of 12-16 inches. 34.5% (n=40) kept them at <12 inches and 6.9% (n=8) kept them at >16. In study done by Nooren *et al*[7] distance from both laptop/desktop (< forearm) and distance from mobile (<12 inch) were significantly associated with CVS symptoms. However, our study didn't find significant association between distance from laptop/ computer and distance from mobile with DES (P=0.99,0.50 respectively). This may be due to response error, where students replied the approximate distance without actual measurement. Similarly, study done by Mohan *et al*[10] didn't find any significant association between screen distance and DES among children. Some studies reported that a shorter distance has been associated with high risk of DES.[25,26] An increased incidence of eyestrain was reported by Shantakumari *et al*[25] in their study of students who watched computer screens at a distance of <50 cm. The American Academy of Ophthalmology[27] has recommended a minimum distance of approximately 25 inches (about an arm's length) from the screen when using a computer. Bilton[28] has described the rule of (1,2,10) for the distances of digital devices: mobile phone at a distance of one foot, desktops and laptops at a distance of two feet, and television at a distance of ten feet.

The posture students adopted during online classes were both lying and sitting by 56 (48.3%). Forty-one (35.3%) students used sitting position during online classes whereas nineteen (16.4%) students were lying during online classes. The posture of the students while using digital device was not significantly associated with DES in our study (P=0.08). This finding was consistent with the results of studies done by Ghufran A. Abudawood *et al*[29] and Khola Nooren *et al*[7] where they didn't find significant association between posture and CVS symptoms. The level of computer screen was kept at the eye level by 57 (49.1%) students, below the eye level by 56 (48.3%) students and above the eye level by 3 (2.6%). In our study, we didn't find significant association between level of computer and DES (P= 0.41). However, there was a significant association between level of screen with headache (P=0.02) and neck & shoulder pain (P=0.04). In contrast to our study, the study done by Reddy *et al*[19] found significant association between level of computer screen and CVS symptoms (P=0.0001). Similar to our study Ghufran A. Abudawood *et al*[29] also reported no significant association between level of computer and DES(P=0.60). Previous studies[30,31] have recommended placing the screen 20 degrees lower than eye level. 50.9% (n=59) of our students took break at less than 1hour while 49.1%(n=57) of them took break at more than 1 hour duration. We didn't find any significant association between frequency of breaks and DES (P= 0.26). Similarly, other studies by Reddy *et al*[19] and Ghufran A. Abudawood[29] didn't find significant association between taking breaks and CVS symptoms (P=0.32,0.68) respectively. In contrast to this, Khola Nooreen *et al*[7] and Hassan *et al*[32] reported significant association between frequency of break more that 60 minutes and symptoms of CVS. Lograj *et al*[33] also reported that those students who were using computer continuously for more hours were at higher risk developing CVS syndrome compared to students who spend less hours and took frequent breaks.

Taking breaks in between the use of computer is the most common preventive measures taken for the relief of symptoms of CVS.[19] Anshel[34] and Reddy *et al*[19] has recommended to take breaks after 20 minutes of computer usage, look at

something 20 feet away for 20 seconds (20-20-20 rule) to relief the symptoms of CVS.

The preventive measures like adjustment of brightness and glare of the screen, voluntarily blinking of eyes during prolong use of digital device, looking at the far object during break, use of radiation filter while using laptop/ computer were not significantly associated with DES in our study.

Screen brightness was associated significantly with the developing of CVS in study done by Abudawood *et al.*[29] Specifically, higher brightness was correlated significantly with increased sensitivity to light. Similarly, higher brightness increased the incidence of headache among university students in Ajman. In addition, using computers in dark screen increased the incidence of dry eyes in a study done by Shantakumari *et al.*[25] Similar to our study, preventive measures like voluntarily blinking of the eyes showed no significant association in the study done by Abudawood *et al.*[29] Reddy *et al*[19] reported that looking at far objects frequently during work was associated significantly with less frequent CVS symptoms. Applying this rule showed improvement in work efficiency in other previous studies also.[35,36] Using screen filters might help reduce glare and reflections from the screen, especially in situations when sitting with the back to an unshaded window.[3] In a study done by Abudawood *et al*[29], majority of students (86.88%) were not using screen filters, and no association with CVS was observed. Similarly, Reddy *et al*[19] reported that using screen filters was not associated with reduced symptoms. However, this is contrary to the finding of Ranasinghe *et al*[18] who found significantly higher CVS among those not using screen filters. Shantakumari *et al*[25] added that the risk of developing tired and dry eyes was increased among students not using screen filters.

In our study, preventive measures like use of lubricating eye drop during prolong use of digital device were significantly associated with less frequency of DES (P= 0.03). Twenty three students (19.8%) were using lubricating eyedrop in our study. Consistent to our study, Reddy *et al*[19] reported significant association between use of eyedrops and less frequency of CVS symptoms. He reported that eyedrop rewet the ocular surface, contribute to tear volume; and thus, decrease symptoms of ocular tiredness, dryness and difficulty in focus, thus improve dynamic visual acuity. The prolonged use of digital devices reduces the blink rate, which can lead to dry eyes.[37-39] Artificial tears were recommended to relieve dryness symptoms and aid in eye lubrication.[19] It was determined that the use of artificial tears could help decrease,[19,40] but not resolve,[41] ocular discomfort associated with digital device use. Although the majority of participants (65%) reported using lubricating drops, the rate of DES-related symptoms was still high in the study done by Balsam Alabdulkader.[8] He concluded that, with extensive digital device use, DES-related symptoms may surpass the comforting effect of the lubricating drops.

In our study, use of ARC/Blue ray cut glasses has been significantly associated with less DES (P= 0.01) and less frequency of burning sensation (P= 0.02). Blue light disturbs the circadian rhythm. The circadian rhythm disturbances can be controlled to an extent using in-built blue light filters in the devices themselves, or plain glasses with a slight yellow tint, called “blue light filter glasses.” These glasses do not need a prescription, since they are plain glasses with a slight yellow tint. The use of these might just be limited to reducing circadian disturbances over anything else.[21] The AAO does not recommend any special eyewear for digital eye strain till date.

In our study, 94.8% students(n=110) knew about the deleterious effect of digital device usage on eye. However, only thirty-four students (n=34, 29.3%) have heard about 20-20-20 rule to prevent computer vision syndrome and only twenty-one students (18.1%) practice 20-20-20 rule. In a study done among the medical students of Institute of Medicine, Nepal only 22.9% of respondents were aware of CVS and its effect.[42] So, it is recommended to raise awareness among students about DES and 20-20-20 rule to reduce DES- related symptoms.

The main limitation of this study was that it was a questionnaire- based survey and lacked subjective examination of students for DES, which was not possible during Covid-pandemic lockdown and it included only a single batch medical students.

In conclusion, increased duration of digital screen exposure during Covid-19 pandemic has led DES as an emerging public health problem worldwide. Our study concludes that the students were predisposed to DES because of increased duration of digital device usage during Covid-19 pandemic largely due to online classes. Hence, like other studies reported previously, we also recommend to follow 20-20-20 rule to decrease DES- related symptoms.

Adjustment of ambient light in environment to avoid glare and reflection, using antiglare filters to improve contrast, maintaining the computer screen at greater than 36 inches and smart phone screen beyond 40cm, placing the screen 20° lower than eyelevel, using computer glasses (blue-filtering glasses) with anti-reflecting coating are the other recommended practices to ameliorate digital eye strain.

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REFERENCES

1. Ghebreyesus, TA. WHO Director-General's opening remarks at the media briefing on COVID-19-11 March 2020. World Health Organization, 2020.
2. Madhan MRR. Computer vision syndrome. *Nurs J Ind* 2009; 100: 236-7
3. Association AO. The effects of computer use on eye health and vision. Internet: https://www.aoa.org/ Documents/optometrists/effects-of-computer-use.
4. Loh K, Reddy S. Understanding and preventing computer vision syndrome. *Malay Fam Phys* 2008; 3: 128-30.
5. Hazarika A, Singh PK. Computer vision syndrome. *SMU Med J* 2014; 1: 132-8.
6. Babu JV, Abraham S, Biju MJ, Jose J. Impact of digitalization in the eye strain during Covid-19 lockdown period: An epidemiological study. *J Drug Delivery Therapeutics* 2021; 11: 7-14
7. Noreen K, Ali K, Aftab K, Umar, M. Computer vision syndrome (CVS) and its associated risk factors among undergraduate medical students in midst of COVID-19. *Pak J Ophthalmol* 2021; 37: 102-8.
8. Alabdulkader B. Impact of precautionary lockdown measures during the COVID-19 pandemic on the development of digital eye strain among contact lens users. *Int J Ophthalmol Visual Sci* 2021; 6: 94-100. DOI: 10.11648/j.ijovs.20210602.16
9. Seguí Mdel M, Cabrero-García J, Crespo A, Verdú J, Ronda E. A reliable and valid questionnaire was developed to measure computer vision syndrome at the workplace. *J Clin Epidemiol* 2015; 68: 662-73. DOI: 10.1016/j.jclinepi.2015.01.015.
10. Mohan A, Sen P, Shah C, Jain E, Jain S. Prevalence and risk factor assessment of digital eye strain among children using online e-learning during the COVID-19 pandemic: Digital eye strain among kids (DESK study-1). *Indian J Ophthalmol* 2021; 69: 140-4.
11. Ganne P, Najeeb S, Chaitanya G, Sharma A, Krishnappa NC. Digital eye strain epidemic amid COVID-19 pandemic - A cross-sectional survey. *Ophthalmic Epidemiol* 2021; 28: 285-92. DOI: 10.1080/09286586.2020.1862243.
12. Bahkir FA, Grandee SS. Impact of the COVID-19 lockdown on digital device-related ocular health. *Indian J Ophthalmol* 2020; 68 : 2378-83. DOI: 10.4103/ijo.IJO_2306_20.
13. Wang L, Wei X, Deng Y. Computer vision syndrome during SARS-CoV-2 outbreak in university students: A comparison between online courses and classroom lectures. *Front Public Health* 2021. 9: 696036. DOI: 10.3389/fpubh.2021.696036.
14. Cole BL, Maddocks JD, Sharpe K. Effect of VDUs on the eyes: report of a 6-year epidemiological study. *Optom Vis Sci* 1996; 73: 512–28. DOI:10.1097/00006324-199608000- 00001.
15. Hayes JR, Sheedy JE, Stelmack JA, Heaney CA. Computer use, symptoms, and quality of life. *Optom Vis Sci* 2007; 84: 738–44. doi:10.1097/OPX.0b013e31812f7546.
16. Hagan S, Lory B.Prevalence of dry eye among computer users. *Optom Vis Sci* 1998; 75: 712–3. DOI:10.1097/ 00006324-199810000-00014.
17. Gonzalez-Perez M, Susi R, Antona B, Barrio A, Gonzalez E. The computer-vision symptom scale (CVSS 17): development and initial validation. *Invest Ophthalmol Vis Sci* 2014; 55: 4504–11. DOI:10.1167/iovs.13-13818.
18. Ranasinghe P, Wathurapatha WS, Perera YS, *et al*. Computer vision syndrome among computer office workers in a developing country: an evaluation of prevalence and risk factors. *BMC Res Notes* 2016; 9: 150. DOI:10.1186/s13104-016-1962-1.
19. Reddy SC, Low CK, Lim YP, Low LL, Mardina F, Nursaleha MP. Computer vision syndrome: a study of knowledge and practices in university students. *Nepal J Ophthalmol* 2013; 5: 161-8
20. Iqbal, M., El-Massry, A., Elagouz, M. and Elzembely, H. 2018. Computer Vision Syndrome Survey among the medical students in Sohag University Hospital, Egypt. *Ophthalmol Res Int'l J* 2018; 8: 1-8. DOI:https://doi.org/10.9734/OR/2018/38436.
21. Sheppard AL, Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. *Brit Med J* Open Ophthalmol. 2018; 3: e000146. DOI:10.1136/bmjophth-2018-000146

22. Fischer-Grote L, Kothgassner OD, Felnhofer A. Risk factors for problematic smartphone use in children and adolescents: A review of existing literature. *Neuropsychiatr* 2019; 33: 179-90.
23. Moon JH, Lee MY, Moon NJ. Association between video display terminal use and dry eyedisease in school children. *J Pediatr Ophthalmol Strabismus* 2014; 51: 87-92.
24. Kozeis N. Impact of computer use on children's vision. *Hippokratia* 2009; 13: 230-31.
25. Shantakumari N, Eldeeb R, Sreedharan J, Gopal K. Computer use and vision-related problems among university students in Ajman, United Arab Emirate. *Ann Med Health Sci Res* 2014; 4: 258-63.
26. Jaschinski-Kruza W. Eyestrain in VDU users: Viewing distance and the resting position of ocular muscles. *Hum Factors* 1991; 33: 69-83. Available from: https://www.aao.org/eye-health/tips-prevention/ computer-usage
27. Bilton N. I live in the future and here is how it works? New York: Crown Business. 2010; 1-293.
28. Ghufran A & Heba M Ashi, Nawaf K Almarzouki. Computer Vision Syndrome among undergraduate medical students in King Abdulaziz University, Jeddah, Saudi Arabia. *J Ophthalmol* 2020; 7: 2789376. DOI: 10.1155/2020/2789376.
29. Jaschinski W, Heuer H, Kylian H. Preferred position of visual displays relative to the eyes: a field study of visual strain and individual differences. *Ergonomics* 1998; 41: 1034 – 49. DOI: 10.1080/001401398186586.
30. Psihogios JP, Sommerich CM, Mirka GA, Moon SD. A field evaluation of monitor placement effects in VDT users. *Appl Ergon* 2001; 32: 313-25. DOI:10.1016/s0003-6870(01)00014-x
31. Hassan A, MMK B. Prevalence of Computer Vision Syndrome (CVS) amongst the students of Khyber medical university, Peshawar. *Islamabad Congress Ophthalmol* 2017; 15: 59.
32. Logaraj M, Priya V, Seetharaman N *et al*. Practice of ergonomic principles and Computer Vision Syndrome (CVS) among undergraduate students in Chennai. *Nat'l J Med Res* 2013; 3: 111-6.
33. Anshel J (ed) (2005). Visual ergonomics handbook. New York, Taylor & Francis.
34. Misawa T, Yoshino K, Shigeta S. An experimental study on the duration of a single spell of work on VDT performance. *Sangyo Igaku* 1984; 26: 296–302.
35. Izquierdo J, Garcia M, Buxo C, Izquierdo N. Factors leading to the computer vision syndrome: an issue at the contemporary workplace. *Boletin de la Assoc Med de Puerto Rico* 2007; 99: 21–8.
36. Blehm C, Vishnu S, Khattak A, *et al*. Computer vision syndrome: A review. *Surv Ophthalmol* 2005; 50: 253-62.
37. Schlote T, Kadner G, Freudenthaler N. Marked reduction and distinct patterns of eye blinking in patients with moderately dry eyes during video display terminal use. *Graefes Arch Clin Exp Ophthalmol* 2004; 242: 306-12.
38. Rosenfield M. Computer vision syndrome: a review of ocular causes and potential treatments. *Ophthalmic Physiol Opt* 2011; 31: 502-15.
39. Acosta MC, Gallar J, Belmonte C. The influence of eye solutions on blinking and ocular comfort at rest and during work at video display terminals. *Exp Eye Res* 1999; 68: 663-9
40. Guillon M, Maissa C, Pouliquen P, Delval L. Effect of povidone 2% preservative-free eyedrops on contact lens wearers with computer visual syndrome: Pilot study. *Eye Contact Lens* 2004; 30: 34-9.
41. Kharel Sitaula R, Khatri A. Knowledge, attitude and practice of Computer Vision Syndrome among medical students and its impact on ocular morbidity. *J Nepal Health Res Counc* 2018. 16: 291-6.