Medical Science

pISSN 2321–7359; eISSN 2321–7367

Difference in prevalence of digital eye strain among students using online e-learning during COVID-19 pandemic in western of Saudi Arabia

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To Cite:
Elhams Y, Fakieha A, Bakry S, Albarakati A, Alshehri F, Alhelali H. Difference in prevalence of digital eye strain among students using online e-learning during COVID-19 pandemic in western of Saudi Arabia. Medical Science, 2022, 26, ms11e1949.
doi: https://doi.org/10.54905/disssi/v26i119/ms11e1949

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Peer-Review History
Received: 23 November 2021
Reviewed & Revised: 25/November/2021 to 31/December/2021
Accepted: 2 January 2022
Published: 7 January 2022

Peer-review Method
External peer-review was done through double-blind method.

URL: https://www.discoveryjournals.org/medicalscience

ABSTRACT

Background: Due to the increased use of digital devices and advanced technology in the last year, digital eye strain is a significant health problem leading to serious complications if it is not well managed. Our study surveyed students from schools and universities in western Saudi Arabia. We compared the prevalence and associated factors of DES among students. *Methodology:* A survey-based study was carried out among students in western schools and Umm Al-Qura University between September 2021 and October 2021. *Results:* The total student's number in the current study was 347. Their mean age was 1.66 ± 0.47 years. Overall, 198 (57.1%) participants were males, and 149 (42.9%) were females. Furthermore, 176 (50.7%) participants were university students, while 171 (49.3%) were school students. *Conclusions:* out of DES symptoms; headache, blurred vision, and shoulders pain shows a significant association correlated with participants' gender (P-values, 0.000, 0.002, and 0.000, respectively), while the only symptom of eye dryness shows significant association associated with participants' educational level (P-values, 0.001).

Keywords: prevalence, Digital eyestrain, COVID-19 pandemic, students, Saudi Arabia.

1. INTRODUCTION

The American Optometric Association defined Digital eye strain (DES) or Computer vision syndrome (CVS) as a wide variety of symptoms such as headache, neck pain, burning and itching eyes due to near work or prolonged use experienced during digital devices (Daum et al., 2004). Digital device usage has steadily increased with time and the advent of technology in the last

years. As a result, Digital Eye Strain (DES) is becoming a common problem affecting the whole world and getting more attention in scientific researches for the previous 20 years (Sheppard & Wolffsohn, 2018). A survey study in 2016 shows an overall DES symptom prevalence commonly in females of 65% more than males and individuals who used more than one device simultaneously (The Vision Council, 2016).

A drastic increase immediately followed the usage of computers, smartphones, and laptops for time spent on these gadgets since the affirmation of the COVID-19 pandemic and declaration of the lockdown (Bahkir & Grandee, 2020). Due to this worldwide pandemic, many governments decided to maintain social distance to reduce virus transmission (Mohan et al., 2021). It shifted the whole process of education to online teaching, bringing a significant challenge to the visual system across all ages in the entire world (Mohan et al., 2021). Up to our knowledge there are limited studies investigating DES in COVID-19 pandemic in western of Saudi Arabia. Therefore, this study aimed to assess the prevalence of digital eye strain among schools and university students using online e-learning during the COVID-19 pandemic in Makkah city.

2. SUBJECTS AND METHOD

A cross-sectional study was conducted as survey-based. The study was executed from 2021 after acquiring the ethical approval for Umm-Alqura IRP. The included populations were both males and females of high schools in western of Saudi Arabia and Umm Al-Qura university students. Then, after collecting the names of all primary schools in the Makkah region from the ministry of education in the Makkah region website, they were divided into seven categories according to regions: north, south, east, west, central, Bahrah and Al-Jamome regions. Then, schools were organized alphabetically. Then we use the website (Random.org) to select two schools from each region randomly. On the other hand, university students were randomly selected according to gender and their college in Umm Al-Qura University.

The sample size was computed according to Epi Info™ 7.1.5 (Center for Disease Control and Prevention; Atlanta, Georgia, USA); therefore, the minimum sample size to achieve a precision of ±5% with a 95% confidence interval is 341. A questionnaire was distributed among students in English and Arabic languages; the questionnaire idea was driven from previously published articles (Mohan et al., 2021; Al Tawil et al., 2020). The questionnaire was then distributed among students on paper to get an accurate response and online version by Google platform (the newest version was provided); however, due to the status of the COVID19 pandemic, we only rely on online questionnaires as a weak tool for strabismus diagnosis.

The questionnaire was classified into three parts. We first collected the educational and demographic information of students. Then, we gathered general information about the COVID-19 pandemic relying on the previously published article (Mohan et al., 2021). Finally, in the third part of the questionnaire, the amount and frequency of screen time exposure before and after lockdown and the influence of lockdown on DVS symptomatology were gathered, relying on the previously validated questionnaire (Al Tawil et al., 2020).

The questionnaire was distributed to students between March 2021 and September 2021 after stratification into randomly chosen classes. Any inquiry about the questionnaire from participants was answered on the spot by the researchers. Participants were provided their agreement to contribute in the study and responded to the questionnaire of their own volition. A written and online informed consent was obtained from all students; students who agreed to participate in this study were included, while those who disagreed to participate were excluded.

We used Microsoft XL spreadsheets to enter the data. Data were uploaded to a Statistical Package for the Social Studies (SPSS) version 23 spreadsheet after checking for completeness and minor typographical mistakes (IBM, Armonk, NY). Descriptive statistics were expressed as percentages for categorical variables and mean standard deviation for continuous variables, with a p-value of less than 5% considered significant. The Chi-square test was used to compare categorical variables.

3. RESULT

A total of 347 students from schools and universities in the western region of Saudi Arabia were surveyed. (Table 1) shows students' educational demographic distribution; there was a similar close number of male and female participants, with 198 male students (57.1%) and 149 male participants (42.9%). The average ages of participant's were1.66 ± 0.47 years; approximately three-quarters of participants were more than 20 years of age (66.6%), while (33.4%) were less than 20 years of age. Regarding students' educational level, university students were predominant (50.7%) in comparison to school students (49.3%). The majority of the students stated that they have not past diagnosed with an ocular eye disease (72.91%), while (27.09%) of students have a positive history of ocular eye diseases (Table 1 and Figure 1). On the other hand, most of the students were not aware of the 20-20-20 rule

(73.78%), while (26.22%) were aware (Table 1 and Figure 2). 16-subgroups of questions aimed to assess demographic characteristics, associated factors, and details of digital device usage concerning digital eyestrain; its frequency was discussed (Table 2).

Table 1 Demographic data

Variable	Category	Frequency (%)
Age *(mean [SD])*	*(1.66[0.47])*	
Age	Less than 20	116 (33.4%)
	20 or more	231 (66.6%)
Gender	Male	198 (57.1%)
	Female	149 (42.9%)
Educational level	university	176 (50.7%)
	School	171 (49.3%)
Past history of ocular eye diseases	Yes	94 (27.09%)
	No	253 (72.91%)
Awareness of 20-20-20 rule	Yes	91 (26.22%)
	No	256 (73.78%)

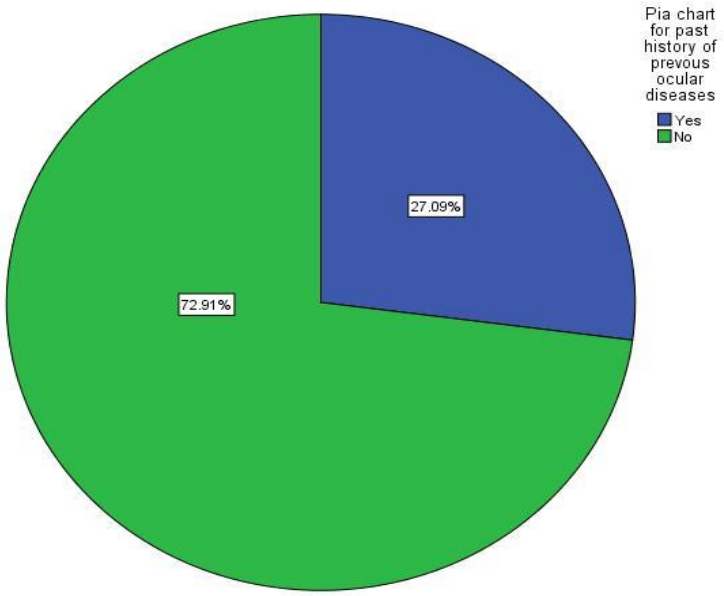

Figure 1 pie chart for past-history of ocular eye diseases

Table 2 demographic characteristics, associated factors, and details of digital device usage concerning digital eye strain

Demography	Percentage (%)
Which device he/she is using for online classes? Computer/desktop Laptop Smartphone Notepad/iPad	 18.7 27.1 24.8 29.4
Which is preferred device for online classes? Computer	 26.2

Laptop	33.1
Notepad	16.7
Smartphone	23.9
What is the average distance of device from eyes during online classes?	
10-18 inches	49.9
18-20 inches	32.9
21-25 inches	11.5
> 25 inches	5.8
How many total hours student is using digital devices in a day during lockdown?	
1 hour	3.5
2 hours	3.2
3 hours	8.6
4 hours	9.5
5 hours	11.5
> 5 hours	63.7
How many total hours student is using digital devices in a day before lockdown?	
1 hour	5.5
2 hours	13.8
3 hours	13.8
4 hours	13.8
5 hours	13.0
> 5 hours	40.1
How many hours student is watching TV?	
< 1 hour	58.8
1 - 2 hours	20.2
> 2 hours	21.0
How many hours student is playing video games on smartphones?	
< 1 hour	62.5
1 -2 hours	15.6
> 2 hours	21.9
How many hours do you spend on electronic devices a day?	
Less than 2h	13.5
204 h	32.3
5 or more h	54.2
Do you take breaks during the use of electronic devices?	
Yes	79.8
No	20.2
How often do you take breaks during the use of electronic devices?	
Every 30 min	31.7
Every hour	30.3
More	38.0
What is the average duration of your breaks?	
Less than 5 min	17

5-10 min	27.4
11-15 min	18.2
More than 15 min	37.5
While using electronic devices the distance between my eye and the screen is approximately?	
Less than 40 cm (less than an arm's length away)	51.0
Between 40 and 76 cm (about an arm's length away)	29.1
More than 76 cm (more than an arm's length away)	4.0
I don't know	15.9
While using electronic devices most of the time my seating position is?	
Up right with a straight back	28.2
Bending my back	39.2
Lying down	32.6
Do you use monitor filters?	
Yes	24.2
No	75.8
How bright is your monitor?	
Very bright	13.3
Bright	39.2
Dull	40.1
Very dull	7.5
How well illuminated is the room during your usage of electronic devices?	
Very bright	8.1
Bright	37.2
Dull	44.4
Dark	10.4

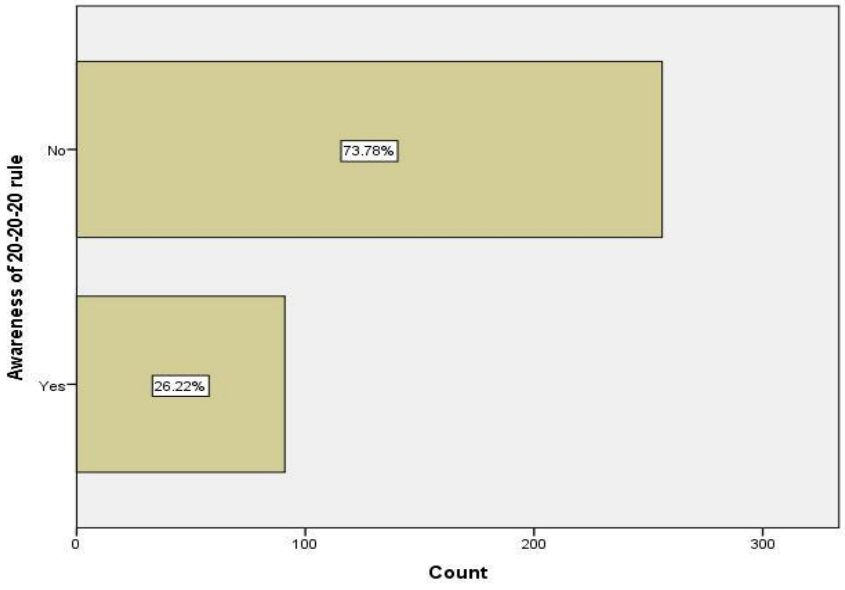

Figure 2 chart for awareness of 20-20-20 rule

The digital eyestrain symptoms varied in association with respondents' gender and educational level described in (Table 3). Therefore, there was a significant difference between participants' gender and symptoms of headache, blurred vision, and shoulders pain (P-values, 0.000, 0.002, and 0.000, respectively). On the other hand, there was eloquent difference between participants' educational level and eye dryness (P-values, 0.001).

Table 3 association of digital eye strain symptoms and students' gender and educational level

Symptoms		University	School	p-value	Male	Female	p-value
Headache	No symptoms	68 (48.2%)	73 (51.8%)	0.751	104 (73.8%)	37(26.2%)	0.000*
	Mild	63 (54.3%)	53 (45.7%)		56 (48.3%)	60(51.7%)	
	Moderate	33 (48.5%)	35 (51.5%)		34 (50.0%)	34(50.0%)	
	Severe	12 (54.5%)	10 (45.5%)		4 (18.2%)	18(81.8%)	
Burning sensation	No symptoms	68 (43.9%)	87 (56.1%)	0.065	91 (58.7%)	64(41,3%)	0.361
	Mild	67 (54.0%)	57 (46.0%)		74 (59.7%)	50(40.3%)	
	Moderate	35 (63.6%)	20 (36.4%)		28 (50.9%)	27(49.1%)	
	Severe	6 (46.2%)	7 (53.8%)		5 (38.5%)	8 (61.5%)	
Eye redness	No symptoms	92 (48.2%)	99 (51.8%)	0.189	117 (61.3%)	74(38.7%)	0.322
	Mild	57 (54.3%)	48 (45.7%)		55 (52.4%)	50(47.6%)	
	Moderate	19 (46.3%)	22 (53.7%)		20 (48.8%)	21(51.2%)	
	Severe	8 (80.0%)	2 (20.0%)		6 (60.0%)	4 (40.0%)	
Blurred vision	No symptoms	105 (53.6%)	91 (46.4%)	0.588	129 (65.8%)	67(34.2%)	0.002*
	Mild	40 (44.9%)	49 (55.1%)		43 (48.3%)	46(51.7%)	
	Moderate	23 (48.9%)	24 (51.1%)		19 (40.4%)	28(59.6%)	
	Severe	8 (53.3%)	7 (46.7%)		7 (46.7%)	8 (53.3%)	
Eye dryness	No symptoms	77 (41.0%)	111 (59.0%)	0.001*	117 (62.2%)	71(37.8%)	0.083
	Mild	63 (63.0%)	37 (37.0%)		55 (55.0%)	45(45.0%)	
	Moderate	25 (58.1%)	18 (41.9%)		20 (46.5%)	23(53.5%)	
	Severe	11 (68.8%)	5 (31.3%)		6 (37.5%)	10(62.5%)	
Shoulder pain	No symptoms	57 (46.3)	66 (53.7%)	0.290	91 (74.0%)	32(26.0%)	0.000*
	Mild	50 (50.5%)	49 (49.5%)		48 (48.5%)	51(51.5%)	
	Moderate	52 (59.1%)	36 (40.9%)		45 (51.1%)	43(48.9%)	
	Severe	17 (45.9%)	20 (54.1%)		14 (37.8%)	23(62.2%)	

4. DISCUSSION

The present study has 347 participants from schools and universities in the western region of Saudi Arabia who was surveyed and analysed. The majority of current study subjects were males, 57.1%. In line with an Indian study conducted by (Logaraj et al., 2014), the majority were males, 52.4%, and 47.6% were females. Different from an Ethiopian survey conducted in 2019 (Mekonnin et al., 2021), which reveals that the majority were females, while another Indian study conducted by (Mohan et al., 2021), where the majority were females 53.46%, and 46.54% were males. The predominant age of the current study was more than 20 years, which is in line with the Ethiopian study (Mekonnin et al., 2021), which reveals the predominant age belonged to the age category 26-35 years 62.2%. However, this disagrees with (Mohan et al., 2021), which indicates that the main age of participants was less than 20 (range 10-18 years).

The current study found that neck and shoulder pain was the most commonly reported severe symptoms in both males 37.8% and females 62.2% followed by blurred vision for males 46.7% and burning sensation for females 81.8%. A similar study in Saudi Arabia conducted in 2020 (Al Tawil et al., 2020), found the most commonly reported severe symptoms were neck and shoulder pain 11.8%, followed by dry eyes 5.6%, blurred vision 2.8%, and burning sensation 2.8%. Conversely, the Ethiopian study (Mekonnin et al., 2021), showed that the main severe problems reported were extra-ocular symptoms 5.5% followed by eyestrain 4.6% and itching 3.7%. On the other hand, (Logaraj et al., 2014) found the most commonly reported severe symptoms were neck and shoulder pain in females 66.7% followed by headache 50%, while in males were burning sensation 40.4%, followed by blurred vision 27.5% and dry

eyes 29.8% were the most commonly reported severe symptoms. In contrast, (Mohan et al., 2021), showed that the most common symptoms reported were headache and itching in 53.9% of cases.

Furthermore, the current study reveals that the least common reported severe symptoms for males were burning sensation 18.2% followed by headache 38.5%, dry eyes 37.5% and redness 60% while in females were redness 40% followed by blurred vision 53.3% and dry eyes 62.5%. In contrast, the Saudi Arabian study (Al Tawil et al., 2020), showed that the least common reported severe symptoms were redness 1.4% followed by headache 2.4%, In the Ethiopian study (Mekonnin et al., 2021), showed that double vision 0.00% were the main least severe symptoms followed by redness 0.5%, watery eye 0.5% and change in color perception 0.5%. While in the (Logaraj et al., 2014), the least common severe symptoms for females were redness 16.7%, dry eyes 18.7%, redness 20.6%, and blurred vision 27.5% were the least common severe symptoms in males. In addition, (Mohan et al., 2021), found that the least common severe symptoms were double vision 11.1%.

The current study found most of the students were using notepads for online classes 29.4%. While in (Mohan et al., 2021), found the most devices used for online classes was smartphone 61.7%. The current study found most of the students were using digital devices for more than 5 hours a day during lockdown 63.7% and 40.1% before lockdown. While in (Mohan et al., 2021), showed that the students used digital devices more than 5 hours during lockdown 36.9% and 1.8% before lockdown. Elseways there was a variation, the Saudi Arabian study (Al Tawil et al., 2020), showed that most participants used digital devices for more than 5 hours 55.3% had more than three symptoms. Similarly, most of the current study were not aware of the 20-20-20 rule 73.8% in line with the Saudi Arabian study (Al Tawil et al., 2020), where most of the participants were not aware of the 20-20-20 rule 49.9% had more than three symptoms, and 50.1 had fewer than three symptoms. The present study found 58.8% who watch television less than 1 hour and 62.5% use smartphones for playing video games for less than 1 hour. While in (Mohan et al., 2021), showed that the participants use of television was 33.6% less than 1 hour and 55.3% who used of smartphone for playing video games for less than 1 hour.

The current study reveals that the average distance from the device during online classes was 10-18 inches in 173 49.9% and 18-20 inches in 114 32.9%. While in (Mohan et al., 2021), showed the average distance from the device during online classes was more than 18 inches in 68.4% and less than 18 inches in 31.6%.

Study limitation

Our study results' do not illustrate among all schools and universities in Saudi Arabia; thus, we recommend further investigation to estimate the prevalence of DES among students during COVID-19 lockdown.

5. CONCLUSION

COVID-19's impact will likely last for years, and the current generation's use of technology will define them. Virtual education will become significant thus need well managed to avoid ocular consequences. Our study highlights the changing educational trend and the negative impact on students' eyes in the form of DES. The findings show that the single symptom of eye dryness has a significant association with participants' educational levels. Still, the other DES symptoms of headache, blurred vision, and shoulder pain strongly correlate with participants' gender. Thus, a causal association with digital displays could be demonstrated in the future by comparing reactions to symptoms recorded during live learning. In addition, students should be taught how to bring their DES levels down.

Acknowledgement

We thank the participants who were all contributed samples to the study.

Ethical approval

The study was approved by the Medical Ethics Committee of Umm Al-Qura University (ethical approval code: (HAPO-02-K-012-2021-11-816)

Funding

The study did not receive any external funding

Conflict of interests

The authors declare that there are no conflicts of interests.

Data and materials availability
All data associated with this study are present in the paper.

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