Population Perceived Eye Strain Due to Digital Devices Usage During COVID-19 Pandemic

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Abstract

Purpose: To assess the magnitude severity and determinants of eyestrain and the use of digital devices in a Saudi population during the COVID-19 pandemic lockdown.

Methods: This web-based survey was conducted in September 2020 and enrolled only Saudi nationals 15 years or older. Data were collected on demographics, eye strain related symptoms, severity, and the use of optical aids during the COVID-19 lockdown. The frequency and severity of eye strain were calculated. A Computer Vision Syndrome (CVS) score was graded as none/ mild moderate and severe, based on the sum of 15-eye strain related signs and symptoms. Correlation analysis was performed for determinants of CVS.

Results: The study sample was comprised of 2,009 individuals with median age of 20 years. Among those who used digital devices for more than 6 hours daily, the main reasons for use were, work and social purposes among 68.4%, and 61% of respondents respectively. The prevalence of knowledge on CVS and the '20-20 rule for using digital devices' was 9.4% and 6.9 respectively. The most common symptoms of eye strain from digital device usage were, headache, burning, itching, tearing, and redness of eyes. Six hours of daily usage of digital devices was positively associated to the grade of eye strain severity during the COVID-19 lockdown ($P<0.05$).

Conclusion: The Saudi population experienced eye strain during COVID-19 lockdown due to excessive digital devices usage. Longer duration of digital device usage was associated to eye strain. Health care providers should educate the general population on measures to mitigate eye strain due to digital devices.

Introduction

After nearly 100 years since the Influenza pandemic, the human population faced the COVID-19 pandemic in 2020 [1, 2]. To prevent high hospitalization rates and mortality, global health organizations recommended personal hygiene, social distancing and restricted mobility especially among high risk groups [3]. Fortunately, there were alternatives to remain in contact with others by using digital devices such as computers, mobile phones and tablets. [4]. Prior to the pandemic, the estimated utilization of daily computer use was 75% [5, 6].

Factors that cause eye strain include, working with digital devices for a long time, poor illumination, usage at less than the recommended distances and not using the required visual aids for clear vision [7]. Eye strain from digital devices is called Computer Vision Syndrome (CVS) or digital device eye strain. CVS is defined as "a complex of eye and vision problems related to near work experienced during computer use" [8].

To combat the pandemic in Saudi Arabia, schools and colleges were initially closed and there was a subsequent transition to online education. This transition often resulted in an excessive use of internet platforms for schoolwork and homework. In the professional environment many jobs transitioned to an online model mainly using videoconferencing. Thus, the risk of eye strain in the Saudi population increased during the lockdown and pandemic.

Prior to the pandemic, the prevalence of eye strain due to CVS among young Saudi students was 69.8%. [9]. More time spent on computers and digital devices was also found to be a risk factor for CVS. Thus, CVS in the Saudi population was likely to increase during the COVID-19 pandemic. Known determinants of CVS include female gender, longer duration of work, type of work, refractive status and compliance to spectacle wear [10, 11]. To the best of our knowledge, the extent and the determinants of CVS and the association to different digital devices have not been evaluated during the Covid-19 pandemic.

This study investigates the prevalence and determinants of CVS and the associated client perceived signs and symptoms of CVS among the Saudi population during the COVID-19 lockdown.

Materials And Methods

A cross-sectional survey was performed in September 2020. The study was approved by the Institutional Research Board (P 0436-20) and adhered to the tenets of the Declaration of Helsinki. Informed consent was electronically obtained from all participants after explaining the aims of the study. For children under 16 years of age, an electronic signature of the parent or legal guardian was obtained.

The study population was comprised of Saudi nationals 15 years or older who had access to digital devices during the study period. Sample size calculations, we assumed that there were 10 million Saudis (15 years or older) using digital devices. Previous literature indicated that the prevalence of eye strain during the COVID-19 pandemic and excessive use of digital devices, would be 67.8% [12]. To achieve 95% confidence interval and 3% acceptable error margin with clustering factor of 2, at least 1,864 participants were required for the survey. To compensate for the incomplete data we increased the sample by 10%. Thus, the final sample for the proposed survey was 2,050 Saudi aged

15 years or older. Stat calculator to calculate the sample size for a cross-sectional study [13]. Subjects were excluded if they refused to participate in the study, were not able to complete survey data, had chronic ophthalmic diseases that resulted in vision that could be fully corrected by spectacles or contact lenses (eg. diabetic macular edema, macular scar, advanced glaucoma, etc).

To quantify digital eye strain, the Computer Vision Syndrome Questionnaire (CVS) was used in this study [14]. The CVS has acceptable psychometric properties, making it a valid and reliable tool to control for the visual health of workers who use computer terminals, and this survey is appropriate for clinical trials and outcomes research [14].

The survey tool was a web-based questionnaire, which was designed by a research coordinator using a Google form. Investigators and a research coordinator used "Research Survey Invitation e-mail account" to invite all researchers at King Khaled Eye Specialist Hospital (KKESH) to participate in this study. Investigators invited people to participate by posting a link in different social platforms. The survey remained open for a period of two weeks. The survey collected data on the profile of participant's covid-19/ quarantine status, refractive status from pre-existing ophthalmic reports, habitual optical aid usage and usage of digital devices. Data were also collected on the purpose of using digital devices, frequency of digital device usage, duration spent on a digital device, symptoms during digital device usage at least half of the time over the previous week [15]. The behavior and status of optical aid usage was assessed as was the knowledge about the '20-20-20 rule' for using digital devices.

There were 15 questions on eye strain signs and symptoms. For each question, the response choices were: never, sometimes and always. Those with signs and symptoms further graded their problem as mild, average and severe (Supplementary Material: 1). According to the American Academy of Ophthalmology, digital device-related eye strain could present as patient complaints of visual blur, achy and tired eyes, dry eyes, or tearing and stinging [12].

Scoring for responses was as follows: (A) frequency of signs/symptoms, never = 0, sometimes = 1, always =2; (B) severity of sign and symptoms, mild =1, average =2 and severe =3. For each sign and symptom, the total score was calculated using a formula score of A X B. The sum of 15 eye strain related signs and symptoms score was further graded as <30 = no or mild CVS, 30 to 59 = moderate CVS and more than 60 = severe CVS. To associate the CVS severity to different determinants we grouped the score into no or mild eye strain and moderate to severe eye strain.

The data were transferred into an Excel spreadsheet (Microsoft Corp., Redmond, WA, USA). After consistency checks and coding, it was transferred to Statistical Package for Social Sciences (SPSS 26; IBM Corp., Armonk, NY, USA). Qualitative data are presented as number and percentage. The eye strain scores are presented as median and interquartile range (IQR). The grade of eye strain was associated to determinants and for two subgroups a 2 X 2 table was used to estimate the Student T test and calculate the Odd's ratio, the 95% confidence interval (CI) and a two-sided *P* value. For more than 3 subgroups, the chi-square value was calculated along with the degrees of freedom and two-sided *P* value. *P* values less than 0.05 were considered statistically significant.

Results

The study sample was comprised of 2,009 participants with median age 20 years (IQR: 18; 22). Table 1 presents the profile of the study sample.

Table 1
Profile of refractive status and usage of digital devices among surveyed Saudi participants

		Number	Percentage
Covid 19 status	Positive	282	14.0
	Negative	1,727	86.0
	Don't know	0	0
Quarantine status	Quarantined	223	11.1
	No	932	46.4
	Missing	854	42.5
Use of spectacles	Spectacles for Clear Vision	393	19.6
	Contact lens cosmetic	59	2.9
	Spectacles and contact lens	55	2.7
	No contact lens or spectacles	1,502	74.8
Purpose of visual aids	Spectacle for reading	72	3.6
	Spectacle for distance	222	11.1
	Spectacle for both	231	11.5
	Missing	1,484	73.9
Last optical check up	Within 1 year	79	3.9
	1 to 2 year	61	3.0
	More than 2 years	1476	73.5
	Not applicable	393	19.6
Duration of using optical aids (hours in week)	1-2 times in the week	79	3.9
	3 times or more in a week Daily	61	3.0
	Other	1,476	73.5
	Daily	393	19.6
Using make up	1 Daily	60	3.0
	1-2 times in the week	100	5.0
	3 times or more in a week	45	2.2
	Not using	1804	89.8
Purpose of using digital devices	Work only	23	1.1
	Social	485	24.1
	Contact	0	0.0
	Both	1,375	68.4
	Other	126	6.3
Duration of digital devices usage	Less than 2 hours	140	7.0
	2-6 hours	644	32.1
	More than 6 hours	1,225	61.0

Two hundred and eighty-two (14%) participants were diagnosed with COVID-19, and 223 (11.1%) were quarantined. Three-fourths of participants did not use contact lens or spectacles, 393 (19.6%) used spectacles, 59 (2.9%) used contact lens and 55 (2.7%) used both

spectacles and contact lens.

There were 1476 (73.5%) participants who had not undergone an optical checkup in the prior two years. Duration of optical aid usage differed between participants, ranging from 1-2 times a week (3.9%) to daily (19.6%). The purpose of using digital devices varied between participants as follows: work only (1.1%), social (24.1%) or both (68.4%). The number of hours spent on digital devices varied among participants, with the majority (61.0%) using them for more than 6 hours.

The prevalence of knowledge of CVS was 9.4% (95% CI: 8.1; 9.6), and the prevalence of knowledge of the '20-20-20 rule' for using digital devices was 6.9% (95% CI: 5.8; 8.0).

Most participants experienced headaches, burning, itching, tearing and redness of eyes related to eye strain from digital devices usage (Table 2).

Table 2
Signs and symptoms of eye strain related to using digital devices as perceived by survey participants

Title	Always		Sometimes		Never	Score Median (IQR)
	Severe	Average	Severe	Average		
1 Burning	35	176	58	1226	514	2.0 (0.0; 2.0)
2 Itching	69	168	96	1267	409	2.0 (0.0; 2.0)
3 Foreign body sensation	54	100	37	835	983	0.0 (0.0; 2.0)
4 Tears (watering)	144	263	58	1145	399	2.0 (0.0; 2.0)
5 Excessive blinking	50	108	34	711	1105	0.0 (0.0; 2.0)
6 Redness	92	123	74	986	734	2.0 (0.0; 2.0)
7 Eye pain	55	106	67	877	906	0.0 (0.0; 2.0)
8 Drooping eyelids	47	74	33	592	1263	0.0 (0.0; 2.0)
9 Dryness of eyes	74	101	36	685	1113	0.0 (0.0; 2.0)
10 Blurring of vision	98	87	60	740	1024	0.0 (0.0; 2.0)
11 Double vision	40	52	33	484	1400	0.0 (0.0; 2.0)
12 Difficulty in focusing near object	101	81	55	820	1052	0.0 (0.0; 2.0)
13 Intolerance to light	174	143	75	702	915	0.0 (0.0; 2.0)
14 Seeing colored halos	62	54	16	530	1347	0.0 (0.0; 2.0)
14 Feeling of worsening eyesight	99	80	50	759	1021	0.0 (0.0; 2.0)
15 Headache	250	195	170	992	402	2.0 (0.0; 4.0)

The median eye strain symptom score was 20 (IQR 10: 32). 'No/ mild' grade of eye strain was reported by 1,486 (74%), moderate eye strain by 468 (23.3%) and severe eye strain by 55 (2.7%) participants. Table 3 presents the determinants of eye strain. Longer than 6 hours of digital device usage per day was statistically significantly positively associated to the grade of eye strain severity ($P<0.001$).

Table 3
Determinants of eye strain due to the digital devices usage during Covid 19 among adult Saudi surveyed participants

		Eye strain of moderate to severe grade (N = 527)		No/mild grade of eye strain (N = 1,488)		Validation
		Number	Percentage	Number	Percentage	
Age group	<30 years	491	93.2	1379	92.7	OR = 1.3 (95% CI 0.8: 1.9) P = 0.26
	31 and older	29	5.5	104	7.0	
Covid status	Yes	73	13.9	193	13.0	OR = 1.2 (95% CI 0.9: 1.7) P = 0.15
	No	394	74.8	1290	86.7	
	Don't know	60	11.4	5	0.3	
Quarantined	Yes	60	11.4	154	10.3	OR = 1.1 (95% CI 0.8: 1.6) P = 0.5
	No	234	44.4	666	44.8	
	Missing	233	44.2	668	44.9	
Digital devised used for	Work only	9	1.7	13	0.9	$\chi^2 = 1.6$ Df = 3 P= 0.2
	Social	116	22.0	353	23.7	
	Both	315	59.8	1024	68.8	
	Other	27	5.1	93	6.3	
	Missing	60	11.4	5	0.3	
Type of visual aid usage	Spectacles for Clear Vision	115	21.8	256	17.2	$\chi^2 = 12$ Df = 3 P<0.001
	Contact lens cosmetic	12	2.3	45	3.0	
		16	3.0	38	2.6	
	Spectacles and contact lens	324	61.5	1144	76.9	
	No contact lens or spectacles	60	11.4	5	0.3	
	Missing					
Visual aid used for	Spectacle for reading	17	3.2	51	3.4	$\chi^2 = 2.3$ Df = 3 P=0.12
	Spectacle for distance	66	12.5	151	10.1	
	Spectacle for both	74	14.0	138	9.3	
	Missing	370	70.2	1148	77.2	
Visual aid checking done	In last one year	124	23.5	316	21.2	$\chi^2 = 0.36$ Df = 3 P=0.54
	1 to 2 years	45	8.5	93	6.3	
	More than 2 years	114	21.6	317	21.3	
	Not applicable	244	46.3	762	51.2	

Discussion/ Conclusion

CVS is a rising public health issue related to continuous use of technology (computers, cell phones and tablets) and is a significant factor in reducing quality of life and workplace productivity [16].

The outcomes of the current study indicate that nearly one-fourth of Saudi participants 15 years or older had symptoms of moderate to severe eye strain. They had a very poor knowledge of CVS and the '20-20-20 rule' for working with digital devices. Working with digital devices for more than 6 hours was positively associated with the presence of signs and symptoms of eye strain ($P<0.001$). There was

excessive use of digital devices among most of the participants. Additionally there was with very poor use of optical aids or regular checks of their refractive status. Very few participants in the current study had COVID-19.

The current study enrolled a large sample of participants and represents a sample of convenience for assessing digital device usage among Saudis aged 15 years and older. Although, this sample may not be representative of the entire adult Saudi population, the findings reflect the habits of the population facing lockdown and forced to overuse digital devices for their business and/or personal use including entertainment, communication and education. The vision/ eye health impact of digital device abuse requires healthcare providers to educate patients on incorporating healthy vision practices among the general population.

In the current study, only 9.4% of participants had adequate knowledge of CVS and only 7% knew about the '20-20-20 rule' for using digital devices. These outcomes were much lower than the proportion of Saudi medical students (91.35%), and Indian students (34%) who knew about CVS [17, 18]. The higher level of knowledge in previous studies could be attributed to the high educational level of the participants with a medical education background [17, 18].

Nearly two thirds of participants in our study used digital devices for professional and social interactions. A previous study also noted increased digital devices usage in the era of COVID-19 for professional and other purposes [19].

We found that the compliance for using visual aids among participants was 3.6%, 11.1% and 11.5% for reading, distance viewing and both respectively. This was much lower than the projected number of individuals with refractive error in this age group of Saudis. The prevalence of refractive error among 16 to 39-year-old Saudis was reported to be 45.8% as follows; 24.4% myopes, 11.9% hyperopes and 9.5% astigmats [20]. Another study, reported refractive error as high as 55.5% among Saudi adolescents [21]. Thus the risk of eye strain will be elevated in a population with a high prevalence of refractive error and low compliance for optical aids.

In our study, 73.5% participants did not undergo optical checkups for more than 2 years and used optical aids sparingly. This could also contribute to ocular strain symptoms. We concur with previous studies that urgent action is warranted to improve compliance with spectacle wear and contact lens usage to address eye strain [22, 23].

In the present study, all participants were using digital devices and majority of them also reported eye strain related symptoms and signs. The most common symptoms associated with digital devices eye strain are headaches, blurred vision, dry eyes and pain in the neck and shoulders. [8] Our outcomes concur with a previous study that reported 62.1% of Saudi medical students had similar signs and symptoms of eye strain [24]. Other studies have also reported a high prevalence of eye strain. Of these studies, a study done in Pakistan (90.4%) [25]. Another study done in India reported a 82.4% prevalence of eye strain among medical and engineering students [26]. The high prevalence of eye strain reported in the present study can be explained by a shift towards excessive use of digital devices during the COVID-19 lockdown. Bahkir et al also found that 93.6% of participants had an increase in their screen time since the lockdown and 56.5% reported increased frequency and intensity of symptoms since the lockdown [18].

Headache was the most commonly reported internal symptoms and the burning sensation with itching were the main external symptoms. However, the majority of reported symptoms were mild. Previous study have also reported headache as the main symptom of eye strain [18, 26]. Headache can be due to prolonged use of digital devices. External symptoms of CVS like burning, irritation, redness and tearing are related to dry eye and the internal symptoms of strain, and headache are linked to accommodative and/or binocular vision stress [7]. They can also be attributed to uncorrected refractive errors, or exposure to a continuous bright light for extended periods of time.

Extended periods of digital device usage (> 6 hours) seem to be a significant risk factor for eye strain in the current study. Other studies from Saudi Arabia reported defined extended duration of digital device usage as more than 4 hours and still reported high rates of eye strain [27, 28, 29]. This relationship between the duration of digital devices usage and eye strain has prompted some experts to suggest a reduction in the number of hours spent in front of computers and other devices to mitigate the risk of serious visual problems [18, 24]. Hence, they recommend public health initiatives directed at the general population on good practices for digital device usage.

In the current study very few participants had COVID-19. Hence, we could not test for an association of this disease and eye strain. The American Academy of Ophthalmology reports that 1%-3% of people with confirmed COVID-19 may have conjunctivitis, either as an initial presenting sign or during advanced stage of the disease [30]. Some common ocular symptoms recorded in patients with conjunctivitis and confirmed COVID-19 infection include: itching, redness, tearing, discharge, and foreign body sensation [30, 31]. The ocular symptoms in patients with conjunctivitis and confirmed SARS-CoV-2 also include itching, redness, tearing, discharge, and foreign body sensation [32]. It will be interesting to study the additive impact of COVID-19 infection on eye strain due to excessive digital devices usage during the lockdown.

There are some limitations to the present study including the cross sectional survey design that precluded an establishment of eye strain to known risk factors. Therefore we recommend judicious interpretation of a causal association of eye strain to risk factors in the current study. The sample size may not be representative of the entire adult Saudi population as the reported symptoms were subjective, self-reported should not be compared by studies based on objective measurements of eye strain.

During the COVID-19 pandemic outdoor activities were limited for children and they spent more time using digital devices for educational purposes and social interactions. Hence, they are vulnerable to a potential eye health effect. We recommend that future studies investigate school children for the magnitude and determinants of eye strain during lockdown. It will also be interesting to study the impact of public awareness campaigns for safe use of digital devices on vision.

Conclusion

The study provides evidence that a significant proportion of the Saudi population is affected by CVS during the COVID-19 lockdown due to abuse of digital devices usage. The digital devices usage varied for work or social interactions. Longer use of digital device usage seems to influence increased symptoms of CVS and severity. The majority of the surveyed population had poor knowledge regarding CVS, self-regulating skills regarding digital screen and media devices.

Health promotion initiatives are recommended that incorporate healthy practices for digital device usage in daily life. These initiatives should focus on periodic checkups of refractive status, regular usage of optical aids as prescribed, address dry eye and incorporated the '20-20-20 rule' during digital device usage.

Declarations

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Statement of Ethics/ Studies involving human subjects

The study was approved by the Institutional Research Board (19th July 2020, P 0436-20) at King Khaled Eye Specialist Hospital. This study adhered to tenets of the Declaration of Helsinki.

Informed consent addressed

Informed consent was electronically obtained after explaining the aims of the study to all subjects who participated in the study. Participants are aware that all collected data will be published.

Trial registration ID

none applicable

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

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Data Availability Statement

All data generated or analyzed during this study are included in this published article.

Author Contributions

Dr. Ashwaq Mohammed J Almalki, contributed in writing the proposal, data collection, writing the discussion, methodology, conclusion and abstract. Mr. Mohammed Alblowi, contributed in writing data collection, writing the introduction. Dr. Ayat Aldosari, contributed in collecting data, writing the results, and conclusion. Dr. Rajiv Khandekar, contributed in reviewing the proposal, doing the statistical analysis, writing methodology, and reviewing the manuscript. Dr. Samar Al-Swailem, contributed in reviewing the proposal, collecting data, and reviewing the manuscript.

Consent to publish

This manuscript does not contain any individual's data in any form (including any individual details, images or videos).

References

1. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. *N Engl J Med*. 2020;382(13):1199-7. doi: 10.1056/NEJMoa2001316.
2. CDC. 2019 Novel coronavirus, Wuhan, China. 2020. Available from <https://www.cdc.gov/coronavirus/2019-nCoV/summary.html>. Accessed 1 Feb 2020.
3. World Health Organization. Novel Coronavirus–China. 2020. Available from <https://www.who.int/csr/don/12-january-2020-novel-coronavirus-china/en/>. Accessed 1 Feb 2020.
4. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020;395(10223):497-506. doi: 10.1016/S0140-6736(20)30183-5.
5. Panth M, Acharya AS. The unprecedented role of computers in improvement and transformation of public health: an emerging priority. *Indian J Community Med*. 2015;40(1):8-13.
6. De' R, Pandey N, Pal A. Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice. *Int J Inf Manage*. 2020;55:102171-6.
7. Sheppard AL, Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. *BMJ Open Ophthalmol*. 2018;3(1):e000146. doi: 10.1136/bmjophth-2018-000146.
8. American Optometric Association. Computer vision syndrome. 2017. Available from <https://www.aoa.org/healthy-eyes/eye-and-vision-conditions/computer-vision-syndrome?sso=y> accessed on 30/12/2020.
9. Alamro MA, Alhumaid ZA, Alokaili HR, A. Alrumayyan A, E. El-Toum M, D. Alomari R, et al. Computer vision syndrome among male and female medical students in King Saud bin Abdulaziz University, Riyadh. *International journal of medicine in developing countries*. 2020;4(9):1410–1415. <https://www.bibliomed.org/mnsfulltext/51/51-1594245805.pdf?1620509381>
10. Wick B, Morse S. Accommodative accuracy to video display monitors: Poster# 28. *Optometry and Vision Science*. 2002;79(12):218. Available from https://journals.lww.com/optvissci/Citation/2002/12001/ACCOMMODATIVE_ACCURACY_TO_VIDEO_DISPLAY_MONITORS_.413.aspx. Accessed on 30/12//2020.
11. Sheppard AL, Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. *BMJ Open Ophthalmol* 2018;16;3(1):e000146.
12. Touma Sawaya R, Meski N, Saba J, Lahoud C, Saab L, Haouili M, et al. Asthenopia Among University Students: The Eye of the Digital Generation. *J Family Med Prim Care*. 2020;9(8):3921-32. doi: 10.4103/jfmpc.jfmpc_340_20.
13. Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version. *Public Health Rep*. 2009;124(3):471-4. doi: 10.1177/003335490912400320.
14. Del Mar Seguí 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 of Clinic Epidemiology*. 2015; 68(6):662-73
15. The American Academy of Ophthalmology. Computers, Digital Devices and Eye Strain. Available from <https://www.aao.org/eye-health/tips-prevention/computer-usage> last accessed on 30/12/2020.
16. Abudawood G A, Ashi H M, Almarzouki N K. Computer Vision Syndrome among Undergraduate Medical Students in King Abdulaziz University, Jeddah, Saudi Arabia. *J of Ophthalmol* 2020(4):1-7.DOI: 10.1155/2020/2789376

17. Aldawsari SA, Alotaibi AA, Alabdulwahhab KM, Mohamed EY, Abdelmajid S. Knowledge, attitudes and practices of faculty members' about computer vision syndrome, Majmaah University, Saudi Arabia. *Int J Community Med Public Health* 2018;5(9):3801-6. DOI: 10.18203/2394-6040.ijcmph20183567.
18. Patil A, Bhavya SC, Srivastava S. Eyeing computer vision syndrome: Awareness, knowledge, and its impact on sleep quality among medical students. *Industrial Psychiatry Journal*. 2019;28(1):68-74. doi: 10.4103/ipj.ipj_93_18.
19. Bahkir FA, Grandee SS. Impact of the COVID-19 lockdown on digital device-related ocular health. *Indian J Ophthalmol*. 2020;68(11):2378-3. doi: 10.4103/ijo.IJO_2306_20.
20. Parrey MUR, Elmorsy E. Prevalence and pattern of refractive errors among Saudi adults. *Pak J Med Sci*. 2019;35(2):394-8. doi: 10.12669/pjms.35.2.648.
21. Alsaqr A, Abu Sharha A, Fagehi R, Almutairi A, Alosaimi S, Almalki A, et al. The visual status of adolescents in Riyadh, Saudi Arabia: a population study. *Clin Ophthalmol*. 2018;12:965-72. doi: 10.2147/OPTH.S162319.
22. Das S, Das R, Kumar A. Computer vision syndrome and its risk factors among professional college students of Agartala: a cross sectional study. *Medical Science*. 2016;5(6):27-9
23. Jaschinski W, König M, Mekontso TM, Ohlendorf A, Welscher M. Computer vision syndrome in presbyopia and beginning presbyopia: effects of spectacle lens type. *Clin Exp Optom*. 2015 May;98(3):228-33. doi: 10.1111/cxo.12248.
24. Al Rashidi SH, Alhumaidan H. Computer vision syndrome prevalence, knowledge and associated factors among Saudi Arabia University Students: Is it a serious problem?. *International J of health sciences*. 2017;11(5):17-9. PMC5669505
25. Noreen K, Batool Z, Fatima T, Zamir T. Prevalence of computer vision syndrome and its associated risk factors among under graduate medical students of urban Karachi. *Pakistan J of Ophthalmol*. 2016;32(3):140-6. Google scholar
26. Logaraj M, Madhupriya V, Hegde S. Computer vision syndrome and associated factors among medical and engineering students in Chennai. *Ann Med Health Sci Res*. 2014;4(2):179-85. doi: 10.4103/2141-9248.129028.
27. Amawi SO, Subki AH, Alkhateeb OS, Alkhateeb O, Fida R, Saggaf O, et al. Use of Electronic Entertainment and Communication Devices Among a Saudi Pediatric Population: Cross-Sectional Study. *Interactive journal of medical research*. 2018;7(2):e9103. <http://ijmr.org/2018/2/e13> accessed on 30/12/2020.
28. Alamri AA, Alhibshi N, Alnefaie M, Alzhrani W, Almaymuni A, Mosli M. Patterns of digital device usage and its related health effects on elementary and middle school students: an instrument development and regression analysis. *Electronic Physician*. 2018;10(10):7333-40.
29. Huang HM, Chang DS, Wu PC. The Association between Near Work Activities and Myopia in Children-A Systematic Review and Meta-Analysis. *PLoS One*. 2015;10(10):e0140419. doi: 10.1371/journal.pone.0140419.
30. American Academy of Ophthalmology. Is It COVID-19 or Allergies? .2020. Available from <https://www.aao.org/eye-health/tips-prevention/coronavirus-versus-allergies-pink-eye>. Accessed on 30/12/2020.
31. Guan WJ, Ni ZY, Hu Y, W-H, Ou C-Q, He J-X, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med*. 2020;382(18):1708-20. doi: 10.1056/NEJMoa2002032.
32. Zhou Y, Duan C, Zeng Y, Tong Y, Nie Y, Yang Y, et al. Ocular Findings and Proportion with Conjunctival SARS-COV-2 in COVID-19 Patients. *Ophthalmology*. 2020;127(7):982-3. doi: 10.1016/j.ophtha.2020.04.028.

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