Prevalence of Computer Vision Syndrome and Patterns of Electronic Devices Usage before and during COVID-19 Pandemic among Medical Students in Riyadh, Saudi Arabia

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Abstract

Purpose: To estimate the prevalence of CVS (computer vision syndrome) among university medical students in Riyadh, Saudi Arabia after establishing remote learning during COVID-19 pandemic and to compare patterns and settings of electronic devices used by students before and during this pandemic.

Methods: This is an observational descriptive cross-sectional study. 1st to 5th year medical students actively enrolled at the governmental colleges of medicine in Riyadh were asked to fill an electronic online questionnaire. The questionnaire included demographic information and various variables to be studied.

Results: A total of 300 medical students were included in this study. 282 (94.0%) reported at least one symptom of CVS. The most frequently reported symptoms were musculoskeletal: neck, shoulder and back pain in 253 (84.3%), headache in 213 (71.1%) and dry eyes in 204 (68%). 38% of the students experienced more severe symptoms while 48% experienced more frequent symptoms during COVID-19 pandemic. The risk factors for experiencing three or more symptoms of CVS were using electronic devices for longer periods (6.8 hours ±2.8) during COVID-19 ($p<0.001$) OR 1.21 [1.09-1.35] 95% CI, and being of female gender ($p<0.001$) OR 3.29 [2.00-5.43] 95% CI.

Conclusion: CVS prevalence during COVID-19 era among medical students is high. This necessitates increasing the awareness of CVS and its preventive measures.

Introduction

Nowadays, looking at electronic screens has become an inseparable part of our lives. This was more exaggerated ever since the beginning of the COVID-19 Pandemic, as governments closed educational campuses worldwide during lockdowns. In March 2020, the Ministry of Education in Saudi Arabia directed all universities to shift teaching to remote learning [1].

Extended hours of studying and spending leisure time on electronic screens may lead to increased prevalence of Computer Vision Syndrome (CVS) which is known as digital eye strain. It is defined by the American Optometric Association as “a group of eye-and vision-related problems that result from prolonged computer, tablet, e-reader and cell phone use” [2]. The most common manifestations of CVS are eye strain, headache, blurred vision, dry eyes as well as neck and shoulder pain. Additionally, poor lighting, glaring at digital screens, improper viewing distances and poor sitting posture may exacerbate and worsen these symptoms.

A study published from Al-Majmaah University, Saudi Arabia prior to the pandemic concluded that the prevalence of visual symptoms related to computer use was 54.8% among university students [3]. Another study conducted in Nepal has estimated the prevalence of CVS in medical students to be 71.6% [4]. Furthermore, one study in Chennai, India, found that 78.6% of medical students had CVS [5]. During the COVID-19 pandemic, few studies assessed the prevalence of CVS among students. Two studies

conducted in India and one in Pakistan showed a high prevalence of CVS with 88%, 93.6% and 98.7% of their participants respectively had at least one eye symptom [6–8].

In our study, we aim to estimate the prevalence of CVS among university medical students in Riyadh, Saudi Arabia after establishing remote learning during COVID-19 pandemic and to compare patterns and settings of electronic devices used by the students before and during COVID-19 pandemic.

Methods

Inclusion and exclusion criteria

This is an observational descriptive questionnaire-based cross-sectional study. The participants are 1st to 5th year medical students who are actively enrolled at the governmental colleges of medicine in Riyadh, : King Saud University (KSU), King Saud Bin Abdulaziz University for Health Sciences (KSAUHS), Imam Mohammad Ibn Saud Islamic University (IMSIU) and Princess Nourah Bint Abdulrahman University (PNU).

The exclusion criteria included students with known ocular pathology like glaucoma, strabismus, severe trauma, undergone refractive surgery for vision correction within the last 6 months or other ocular or eyelid surgeries that may affect the ocular surface health. Also, students with underlying systemic illness like Hypertension, Diabetes, Autoimmune disorders or using medications that have known visual side effects like (isotretinoin, bisphosphonates, Cyclosporine, Tetracyclines, Hydroxychloroquine, Anti-tuberculosis and Anticholinergics) and those who apply topical eye drops other than Artificial tears (Corticosteroids, Antibiotics, Antivirals, glaucoma medications, Anesthetics or Mydriatics) were excluded from the study.

Ethical approval

was obtained from the Institutional Review Board (IRB) of the College of Medicine, King Saud University (approval No. E-21-5842).

Sample size estimation:

The sample size of the study was estimated based on the assumption that the prevalence of computer vision syndrome is around 58% among medical students, with a precision of ±5%, and 95% confidence interval. The minimal sample size required was calculated to be 375 participants.

Data collection tool:

The data of the study were collected through a questionnaire based on already published studies with three validated questionnaires used in references [9, 10, 11]. The questionnaire consisted of four parts: the first part collected demographic information, the second part explored Knowledge, attitude and practice of the students regarding CVS, the third part discussed frequency and severity of eye symptoms

and the fourth and last part enquired about the usedpatterns and settings of electronic devices in daily use before and during the COVID-19 pandemic. The developed questionnaire was reviewed by two senior faculty members, one consultant from the ophthalmology department and another faculty from the department of public health. A pilot study was conducted on 15 students to assess their understanding and the time needed to complete the questionnaire.

Data collection:

Data collection was carried out in the period from April to May 2021 through an electronic self-administered questionnaire distributed to medical students by social media platforms.

An online consent form appeared in the first page of the electronic questionnaire and it was obtained from all potential participants. The participants have a clear explanation of the benefits of their participation and any potential risks. The Participation in the study was completely voluntary and the participants have the right not to complete the study at any time. Confidentiality and privacy of each participant have been assured. The participants' details have been completely anonymous, and they have been used for data analysis only.

Statistical Analysis:

Data were collected, managed and coded in a spreadsheet using Microsoft Excel 2010® software and they were analyzed using SPSS® version 21.0 (*IBM* Inc.، Chicago, Illinois, USA).

Descriptive analysis was done, where categorical variables were presented in the form of frequencies and percentages. Data exploration using Shapiro-Wilk test was done for the continuous variables where the data was found to be normally distributed. Mean ±SD [Range] was reported, otherwise median (interquartile range) (IQR) was reported. Independent t-test and paired samples t-test were used for comparisons between two groups for the continuous variables and Chi-squared test for comparing proportions among the studied groups. Any output with a *p* below 0.05 was interpreted as an indicator of statistical significance.

Results

A total of 300 out of 375 medical students were included in this study. 75 responses were excluded after applying the exclusion criteria. The majority of respondents were females (176, 58.6%) *(*Table1*)*.When assessing the awareness of CVS, 76.3% of our participants never heard of the syndrome. 282 (94.0%) of the respondents reported at least 1 symptom. The most frequently reported symptoms in our study were musculoskeletal in neck, shoulder and back pain (253, 84.3%), headache (213, 71.1%) and dry eyes (204, 68%). (Figure 1) The breakdown of severity of each symptom is shown in Table 2a.

Table 1
Demographic data

Characteristic	n (%)
Age in years, mean ±SD [Range], median (IQR)	21.5 ±1.9 [18-29], 21 (20-33)
Gender	
Male	124 (41.3)
Female	176 (58.7)
Ocular diseases	
Nearsightedness (myopia)	111 (37.0)
Astigmatism	41 (13.7)
Farsightedness (hyperopia)	22 (7.3)
Vision corrective surgery within the last 6 months; like LASIK	1 (0.3)
None	164 (54.7)
Artificial tears use	
Yes	132 (44)
Corrective lens use	
Yes	161 (53.7)
Type of corrective lens (n=161)	
Eye glasses	151 (93.8)
Contact lens	10 (6.2)

Table 2a: Frequency and Severity of each symptoms:

	No symptom n (%)	Mild* n (%)	Moderate** n (%)	Severe*** n (%)
Headache	87 (29.0)	120 (40.0)	81 (27.0)	12 (4.0)
Neck, shoulder or back pain	47 (15.7)	124 (41.3)	110 (36.7)	19 (6.3)
Burning eye sensation	102 (34.0)	111 (37.0)	77 (25.7)	10 (3.3)
Eye redness	148 (49.3)	99 (33.0)	40 (13.3)	13 (4.3)
Dry eyes	96 (32.0)	107 (35.7)	83 (27.7)	14 (4.7)
Watery Eyes	193 (64.3)	64 (21.3)	33 (11)	10 (3.3)
Pain in and around the eyes	165 (55.0)	71 (23.7)	55 (18.3)	9 (3.0)
Blurred vision	159 (53.0)	81 (27.0)	49 (16.3)	11 (3.7)
Double vision	245 (81.7)	33 (11.0)	15 (5.0)	7 (2.3)

*Mild: transient symptoms that persist for a few minutes to hours.

**Moderate: symptoms persist for a few hours and subside after rest or sleep

***Severe: needs medical attention.

Table 2b: Risk factors of having more than 3 symptoms

Risk factor	≤3 symptoms (n=99) n (%)	>3 symptoms (n=201) n (%)	P value
Gender			
Male (n=124)	60 (48.4)	64 (51.6)	<0.001*
Female (n=176)	39 (22.2)	137 (77.8)	
Use of corrective lens			
Yes (n=161)	50 (31.1)	111 (68.9)	0.441
No (n=139)	49(35.3)	90 (64.7)	
Duration of device use in hours pre Covid-19 Mean ±SD	4.9 ±2.0	5.3 ±2.1	0.164
Duration of device use in hours during Covid-19 Mean ±SD	5.6 ±2.3	6.8 ±2.8	<0.001*
P value	0.023*	<0.001*	

*Statistically significant at 5% level of significance

Table 2
c: Part 3: Frequency and Severity of eye symptoms:

Question	n (%)
How often do you experience these symptoms during/after the use of electronic devices, in the last 3 months?	
Always (Symptoms occurring almost everyday)	26 (8.7)
Often (Symptoms occurring 2-3 times a week)	94 (31.3)
Occasionally (Symptoms in occurring sporadic episodes or once a week)	141 (47.0)
Never	39 (13.0)
In comparison to pre Covid-19 era, have you noticed the symptoms listed above becoming more severe during COVID-19 pandemic than before?	
They became more severe	115 (38.3)
No change in severity	168 (56.0)
They became less severe	17 (5.7)
In comparison to pre Covid-19 era, have you noticed the symptoms listed above becoming more frequent during COVID-19 pandemic than before?	
They became more frequent	145 (48.3)
No change in frequency	147 (49.0)
They became less frequent	8 (2.7)

Table 2
d: Association between severity and frequency of symptoms and duration of device use

	More severe (n=115)	**Remains same or less severe (n=185)**	**P value**
Duration of device use in hours pre Covid-19 Mean ±SD	5.4 ±1.8	5.0 ±2.2	0.055
Duration of device use in hours during Covid-19 Mean ±SD	7.5 ±2.8	5.8 ±2.5	**<0.001***
P value	**<0.001***	**0.001***	
	More frequent (n=145)	**Remains same or less frequent (n=155)**	
Duration of device use in hours pre Covid-19 Mean ±SD	5.3 ±1.9	4.9 ±2.2	0.094
Duration of device use in hours during Covid-19 Mean ±SD	7.1 ±2.8	5.9 ±2.4	**<0.001***
P value	**<0.001***	**<0.001***	
*Statistically significant at 5% level of significance			

Table 2e: Association between severity and frequency of symptoms and not taking breaks

	More severe (n=115) n (%)	Remains same or less severe (n=185) n (%)	P value
Taking breaks during the use of electronic devices pre Covid-19			
Yes (n=232)	87 (37.5)	145 (62.5)	
No (n=68)	28 (41.2)	40 (58.8)	0.583
Taking breaks during the use of electronic devices during Covid-19			
Yes (n=232)	85 (36.6)	147 (63.4)	0.265
No (n=68)	30 (44.1)	38 (55.9)	
	More frequent (n=145) n (%)	**Remains same or less frequent (n=155) n (%)**	**P value**
Taking breaks during the use of electronic devices pre Covid-19			
Yes (n=232)	107 (46.1)	125 (53.9)	0.157
No (n=68)	38 (55.9)	30 (44.1)	
Taking breaks during the use of electronic devices during Covid-19			
Yes (n=232)	107 (46.1)	125 (53.9)	0.157
No (n=68)	38 (55.9)	30 (44.1)	

Risk factors for experiencing three or more symptoms of CVS were prevalent among females (p<0.001) OR 3.29 [2.00-5.43] 95% CI (Table2b) and students who used electronic devices for longer periods (6.8 hours ±2.8) during COVID-19 (p<0.001) OR 1.21 [1.09-1.35] 95% CI (Table 2b).

Our study explored the frequency and severity of CVS symptoms among study participants.

At least one symptom of CVS was reported by 282 participants (94.0%). 47% of students experienced CVS symptoms on sporadic episodes or once a week (occasionally). 31.3% experienced the symptoms 2-3 times a week (often). 13% never had any CVS symptoms over the last 3 months. Only 8.7% reported CVS symptoms on a daily basis (always). During the COVID-19 pandemic, symptoms were reported

severer and more frequent by 38% and 48.3% of students respectively. Among those who used artificial tears n=241, 42% experienced improvement in the CVS symptoms with the use of artificial tears. (Table 2c).

The longer the duration of use was, the severer and more frequent the symptoms were with p value of <0.001. (Table 2d)

The association between taking breaks from one hand and severity and frequency of symptoms was not statistically significant. (Table 2e).

One quarter (26%) of the respondents reported spending 8 hours or more on electronic devices pre COVID-19. During the pandemic, the percentage increased up to 56.7% (p <0.001). Also, the average of the total studying hours on devices was 5.1 hours pre COVID-19 and it increased to 6.4 hours during the pandemic (p<0.001). Smartphones were used by 34% of students prior to COVID-19. This percentage decreased to 23% during the pandemic (p=0.002). While using electronic devices, only 22.7% do not take breaks. Among the other 77.3% who took breaks, negligible differences in the frequency and duration of breaks existed. There was no statistical significance between the preferred monitor brightness and room illumination pre and during COVID-19 pandemic (Table 3a).

Table 3
a: Pattern and settings of electronic device usage before and during COVID-19 pandemic

Variable	Group	Pre-COVID-19 n (%)	During COVID-19 n (%)	P value
In general, how many hours do you spend on electronic devices a day?	Less than 2 Hours	6 (2.0)	3 (1.0)	0.314
	2 <4 Hours	21 (7.0)	2 (0.7)	<0.001*
	4-<6 Hours	96 (32.0)	24 (8.0)	<0.001*
	6-<8 Hours	99 (33.0)	101 (33.7)	0.856
	8 hours or more	78 (26.0)	170 (56.7)	**<0.001***
	On average, Total hours of studying hours per day, mean ±SD [range], median (IQR)	5.1 ±2.1 [1–15], 5 (4-6)	6.4 ±2.7 [1–20], 6 (5-8)	**<0.001***
Which of the following is the most device you use?	Desktop	18 (6.0)	21 (7.0)	0.620
	Laptop	41 (13.7)	55 (18.3)	0.125
	iPad/tablets	137 (45.7)	155 (51.7)	0.142
	smartphone	104 (34.7)	69 (23.0)	**0.002***
What is your preferred monitor brightness?	High brightness	39 (13.0)	35 (11.7)	0.629
	Moderatebrightness	159 (53.0)	165 (55.0)	0.623
	Low brightness	102 (34.0)	100 (33.3)	0.856

*Statistically significant at 5% level of significance

Variable	Group	Pre-COVID-19 n (%)	During COVID-19 n (%)	P value
How well illuminated is the room during your usage of electronic devices?	Highly illuminated	58 (19.3)	61 (20.3)	0.759
	Moderatelyilluminated	161 (53.7)	157 (52.3)	0.731
	Slightly illuminated	81 (27.0)	82 (27.3)	0.934
*Statistically significant at 5% level of significance				

Table 3
b: Application of CVS protective measures before and during COVID-19 pandemic

Phrase	Groups	Pre-COVID-19		During COVID-19		P value
		N	**%**	**N**	**%**	
You take short breaks every 20 minutes for 20 seconds and looking at objects that are at least 20 feet away (20-20-20 rule)	**Always**	5	(1.7)	9	(3.0)	0.294
	Usually	19	(6.3)	20	(6.7)	0.843
	Sometimes	51	(17.0)	42	(14.0)	0.310
	Rarely	76	(25.3)	78	(26.0)	0.845
	Never	149	(49.7)	151	(50.3)	0.883
You locate the screen to be 20-28 inches from the eyes (more than arm & forearm length)	**Always**	18	(6.0)	20	(6.7)	0.725
	Usually	31	(10.3)	36	(12.0)	0.509
	Sometimes	63	(21.0)	57	(19.0)	0.541
	Rarely	87	(29.0)	88	(29.3)	0.936
	Never	101	(33.7)	99	(33.0)	0.856
You locate the screen to be at the level of your face	**Always**	40	(13.3)	38	(12.7)	0.827
	Usually	51	(17.0)	61	(20.3)	0.300
	Sometimes	84	(28.0)	85	(28.3)	0.935
	Rarely	67	(22.3)	58	(19.3)	0.366
	Never	58	(19.3)	58	(19.3)	0.998
While using electronic devices, your seating position is up right with a straight back	**Always**	16	(5.3)	18	(6.0)	0.711
	Usually	53	(17.7)	57	(19.0)	0.681
	Sometimes	95	(31.7)	98	(32.7)	0.793
	Rarely	92	(30.7)	90	(30.0)	0.852
	Never	44	(14.7)	37	(12.3)	0.390
While using electronic devices, you use your corrective lens (contact lenses/glasses)?	**Always**	82	(27.3)	87	(29.0)	0.644
	Usually	30	(10.0)	31	(10.3)	0.903
	Sometimes	29	(9.7)	30	(10.0)	0.902
	Rarely	27	(9.0)	21	(7.0)	0.367
	Never	132	(44.0)	131	(43.7)	0.941

Minute differences were found among the patterns and settings of electronic devices used before and during COVID-19 pandemic with no statistical significance. 8% of the respondents utilized the 20-20-20 rule before COVID-19 and the remained percentage unchanged during the pandemic (9.7%). Similarly, locating the screen at 20-28 inches distance was only applied by 16.3% before the pandemic and 18.7% after the pandemic. 27.3% of the respondents reported wearing their corrective lens (contact lenses/glasses) while using electronic devices prior to the pandemic. The remained percentage was almost the same during the pandemic (29.3%). (Table 3b).

Discussion

The Ministry of Education of Saudi Arabia directed the universities and schools to shift to remote learning, so students can attend all their classes from home via electronic platforms like blackboard, ZOOM and Microsoft Teams to ensure their safety and health. But the continuation of E-learning during the COVID-19 era has several drawbacks.

High prevalence of CVS was observed. In our study, 282 students reported at least one symptom (94.0%) which is consistent with the prevalence reported during covid-19 pandemic in Pakistan (98.7%) and India (88%) [6, 7] and also similar to the prevalence in Jeddah, Saudi Arabia before the pandemic (97.3%) [12]. However, in the previous studies, there was no exclusion to students with ocular or systemic illness or to those applying medications with known visual side effects. In our study, all those confounders were eliminated.

In the current study, the most reported symptoms were neck, shoulder and back pain, headache and dry eyes which is similar to what was reported in a previous study among business and medical college students in Riyadh, Saudi Arabia [13], but with a higher percentage in our study; it could be attributed to the increasing duration of e-learning.

In our study, being female increased the risk of having three or more symptoms with a statistical significance. It is matching with what was reported in multiple studies before [3, 10, 12]. This could be attributed to the higher prevalence of dry eyes and cosmetics use among females [9] and to the gender difference in response to pain [14].

The relation between refractive errors and developing CVS has conflicting results in the literature. In our study, we found that having refractive errors as myopia, hyperopia or astigmatism were not risk factors for having more symptoms of CVS. This is almost similar to a national study conducted in Jeddah which found that myopia and hyperopia were not associated with CVS, but astigmatism showed significant association with more symptoms [10]. In contrast, in another national study in Al-Qassim region there was a significant relation between myopia and CVS, especially those corrected with contact lenses [15]. On the international level, a systematic review concluded that those who have refractive errors are at a higher risk to develop CVS or suffer from more severe symptoms of CVS [16]. Moreover, a study conducted in Nepal found that students who have myopia corrected with glasses are at higher risk to

develop CVS. However, the study did not find a statistically significant difference between students who hadhigh myopia and those who had low and moderate myopia in regard to developing CVS [17].

In assessing the awareness of CVS, 76.3% of our participants never heard of the syndrome.

Similar percentage was reported by a study conducted in Nepal where 77.1% of their study population had no pre-existing knowledge of CVS [4]. This highlights the need for more awareness programmes of CVS and its risk factors.

Along with the increased dependence on online education during the pandemic, safe habits in digital device use have been recommended especially in regard to the duration of device use as we found it to be one of the most statistically significant factors in our study. We found out that students who used electronic devices for longer durations during COVID-19 (6.8+_2.8) reported 3 or more symptoms of CVS with p-value (<0.001). The ration of our respondents who reported spending 8 hours or more using electronic devices increased significantly from only 26% pre COVID-19 to 56.7% during the pandemic (p <0.001). Also, the average total studying hours increased from a mean of 5.1 hours reported pre-pandemic to a mean of 6.4 hours during this era with p-value (<0.001)

The increase in symptoms due to longer device use is matching with multiple previous studies that have reported participants experiencing more symptoms after using devices for more than six hours a day [18, 19].On the opposite side, some studies reported that there is no association between the duration of usage of the device and the number of symptoms [12].

The pattern and settings of electronic devices used by our participants remained unchanged pre and during Covid-19. In addition, the majority of the study population were not following preventive measures such as reducing hours of use, room illumination, and monitoring the brightness. In addition, using the 20-20-20 rule and locating the screen at 20-28 inch from your eyes were only applied by a minor percentage of the study population with no significant difference pre and during Covid-19.

These results could be explained by the poor level of awareness among the study participants. Even Tthough 55.3% of the respondents knew about the 20-20-20 rule, only 8% actually applied the rule pre Covid-19 and 9.7% during Covid-19.

Conclusion

High prevalence of CVS symptoms during COVID-19 era was reported, Having three or more symptoms was statistically significant among females. The duration of use during Covid-19 pandemic was associated with more frequent and more severe CVS symptoms. The most Commonly reported symptoms were neck, shoulder and back pain, headache and dry eyes.

Recommendations and limitations

- Our study highlights high prevalence of CVS among medical students which was expected due to the COVID pandemic lockdown and shift to online teaching. However, we encourage future researchers to perform larger community-based studies as there is an expected increase in digitalization for educational and recreational purposes as well.
- Unexpectedly, our study shows a low level of awareness among medical students regarding knowledge of CVS and practical ergonomics. This highlights the need to increase the awareness of CVS through introducing the subject in university's curriculum and frequent campaigns.
- Our study was cross sectional and based on a questionnaire which assessed the prior 3 months.
- Larger studies are required to verify our results. Due to limited accessibility to university students and lack of a national database, our study targeted only medical students in government universities in Riyadh which does not reflect the whole population.

Declarations

Competing Interests: None

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Figures

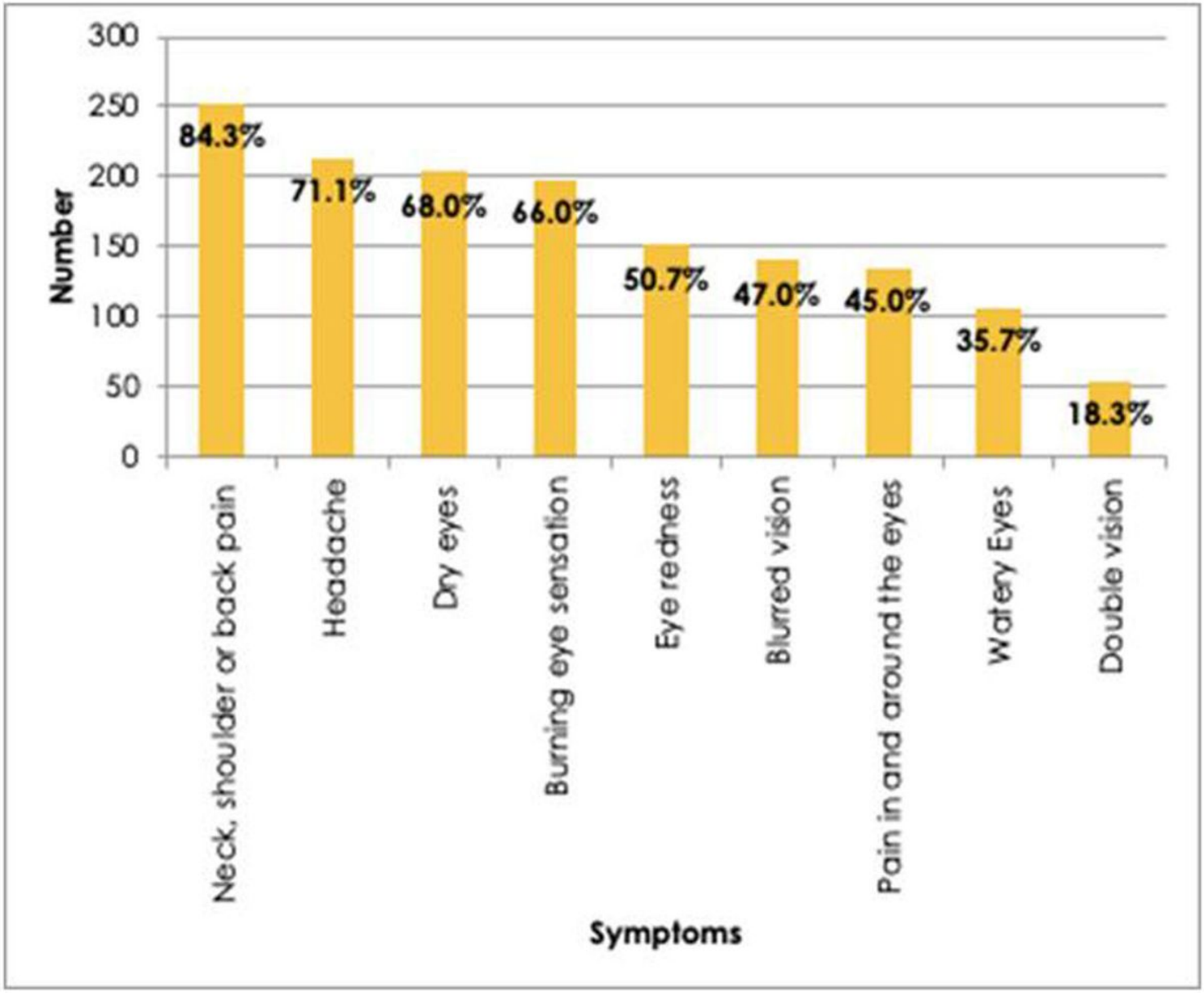

Figure 1

The most frequently reported symptoms