Magnitude and Determinants of Computer Vision Syndrome Among Radiologists in Saudi Arabia: *A National Survey*

Ayman S. Alhasan, MBBS, DES, Waseem A. Aalam, MD

Rationale and Objectives: To assess the magnitude and determinants of computer vision syndrome (CVS) among radiologists in Saudi Arabia using a reliable and validated survey instrument.

Materials and Methods: This nationwide cross-sectional web-based survey took place in April 2021 and included all radiologists and radiology residents residing practicing in Saudi Arabia. We used the reliable and validated CVS questionnaire. Univariate and multivariate analyses were carried out using nonparametric methods. The CVS score was correlated with different demographic- and health-related variables. The Mann-Whitney U test and Kruskal-Wallis test were used to determine if there was a statistically significant difference between subgroups.

Results: The survey was completed by 416 participants. The prevalence of CVS was 65.4% (95% CI: 60.8-70.0). The median CVS score was 7.5 (interquartile range: 4.0; 12.0). Mild CVS was observed in 188 participants (69.1%), moderate CVS was observed in 69 (25.4%), and severe CVS was observed in 15 (5.5%). The most common symptoms perceived by participants were headache (72.1%), dryness (70.7%), burning (63.7%), blurred vision (56.3%), and increased sensitivity to light (55.5%). Multinomial regression analysis suggested that female sex ($p < 0.001$), work as a general radiologist ($p = 0.05$), and the use of eyeglasses ($p = 0.001$) were significant predictors of CVS.

Conclusion: The prevalence of CVS among radiologists in our study was high. Local and international societies need to establish and implement legislative and preventive measures to ensure the safety and ocular and visual health of radiologists.

Key Words: Computer Vision Syndrome; Eyestrain; Occupational hazards; Radiologists; Saudi Arabia.

INTRODUCTION

Radiologists are exposed to unique occupational health hazards, different from those faced by physicians working in other specialties. In the past century, hazards to radiologists caused by overexposure to ionizing radiation have received much attention. The development of new radiation protection guidelines and advances in machine development have resulted in a dramatic decrease in the incidence of exposure to radiation and its related injuries. Several changes in the role of radiologists as health care providers within the health care system have been observed over the last two decades. These changes became more conspicuous due to the greatly increasing impact of information technology on all aspects of the specialty (1). The field of diagnostic radiology has significantly evolved, with a dramatic shift from film-based to filmless images, creating more challenges and increasing the workload of radiologists (2). Currently, a major component of the daily work of a diagnostic radiologist involves sitting and staring at one or multiple high-resolution display monitors with high brightness for long hours to thoroughly examine the radiological images of patients and report the findings therein. These display monitors coupled with high-performance computers are known as picture archiving and communication systems (PACS). Non-radiation occupational hazards such as fatigue, chronic eye strain, and musculoskeletal and mental issues can negatively impact the health of radiologists and lead to an increase in the

Acad Radiol 2022; 29:e197–e204

From the Department of Radiology and Medical Imaging, College of Medicine, Taibah University, Madinah, Saudi Arabia (A.S.A.); Department of Ophthalmology, Faculty of Medicine, University of Jeddah, Jeddah, Saudi Arabia (W.A.A.). Received October 2, 2021; revised October 24, 2021; accepted October 25, 2021. **Address correspondence to:** A.S.A. and W.A.A. e-mails: ahasan@taibahu.edu.sa, waalam@uj.edu.sa

https://doi.org/10.1016/j.acra.2021.10.023

number of medical errors (3). This explains why eye-related hazards among radiologists have gained more attention over the last few years (4).

Computer vision syndrome (CVS) is defined by the American Optometric Association as a group of eye- and vision-related problems that result from prolonged exposure to digital display devices. The reported prevalence of CVS among computer users in the literature is variable and can reach up to 90%. Blehm et al. categorized CVS into four categories. The first category is asthenopic CVS, which includes symptoms of eyestrain, tired, sore, and dry eyes. The second category is ocular surface-related CVS, and it includes eye dryness, burning, grittiness, and heaviness related to differences in age, sex, environmental factors, rate of blinking, use of contact lenses and the length of exposure to monitors. The third category is visual CVS and includes symptoms such as blurred vision, double vision, slowness of focus change, and presbyopia. The fourth category is extraocular symptoms, mainly shoulder, neck, and back pain (5).

A recent editorial in *Academic Radiology* highlighted the importance of studying eye strain and developing strategies that mitigate its negative impact on radiologists (6). In addition, several studies have attempted to investigate and identify various factors related to CVS among radiologists and other professionals using different methods (4,7–11). Given the recent increased interest in this topic, we decided to conduct this national survey, aiming to assess the magnitude and determinants of CVS among radiologists in Saudi Arabia with the use of a reliable and validated survey instrument.

METHODS

This nationwide cross-sectional web-based survey took place in April 2021 and included all radiologists and radiology residents residing and practicing in the Kingdom of Saudi Arabia and registered with the Saudi Commission for Heath Specialties (SCFHS). The sample size was calculated using OpenEpi software (Version 3.0, Open Source Epidemiologic Statistics for Public Health, USA) and an estimated prevalence of CVS among radiologists of 50%. The calculation indicated that a sample size of 387 radiologists was needed, with a design effect of 1.2 for the cluster sample and a confidence level of 95% (12).

An academic radiologist and an academic ophthalmologist designed the survey based on a literature review and after discussion with a focus group of radiologists. Survey data were collected anonymously using the online survey tool JotForm (JotForm; San Francisco, CA). A pilot test was undertaken with 10 radiologists to detect flaws in the survey before more widely distributing the survey. The project and the survey instrument were reviewed and received approval from the Institutional Review Board at the institution of the first author. The SCFHS agreed to send the invitation to participate in our survey by email to all eligible radiologists and radiology residents. The Radiological Society of Saudi Arabia (RSSA) also agreed to send email invitations to its members practicing within the geographical limit of the Kingdome of Saudi Arabia. The invitation was sent on April 8, 2021, and the survey was open for a 5-week period. No personal identifying information was collected. During each stage of the study, the tenants of the Helsinki Declaration were strictly followed.

The demographic and work pattern information collected included age, gender, professional rank according to the SCFHS, number of years of work in the field, subspeciality, and type of institution of current affiliation. The visual aid-related information collected included questions regarding the use of eyeglasses, reading glasses, contact lenses, and history of refractive surgery, in addition to its type and time if present. Information related to work patterns, such as the number of days per week and hours per day spent reviewing cases in front of the monitor, was collected. We also asked participants about the presence of any systemic diseases, such as diabetes, hypertension, and any other chronic disease, and the use and duration of use of devices, such as mobile phones, laptops, tablets, televisions, and wall projectors.

In this survey, we used the reliable and validated CVS questionnaire (CVS-Q) described by Seguí et al. to measure CVS at the workplace (13). A total of 16 ocular- and visual-related symptoms from the CVS-Q were presented to the participants. These symptoms were burning, itching, feeling of a foreign body, tearing, excessive blinking, eye redness, eye pain, heavy eyelids, dryness, blurred vision, double vision, difficulty focusing on near objects, increased sensitivity to light, colored halos around objects, feeling that vision is worsening, and headache. Frequency was defined as how often the symptom occurs: *never* if the symptom never occurs, *sometimes or occasionally* if the symptom occurs sporadically or once per week, and *always or often* if the symptom occurs 2 to 3 times per week or every day.

To measure frequency, participants were asked to report their perception of the frequency of each of the 16 symptoms using the following options: *always or often* = 2, *sometimes or occasionally* = 1, and *never* = 0. To measure the intensity of the perceived symptom, participants were asked to grade the severity using either *mild to moderate* = 1 or *severe* = 2. Symptoms reported as never occurring were automatically scored as 0 (none) on the intensity scale. The following formula was used to calculate the total score:

$$\text{Score} = \sum_{i=1}^{16} (\text{frequency of symptom})_i \times (\text{intensity of symptom})_i$$

To attain a good balance between sensitivity and specificity, a cutoff value of 6 for the total CVS score was used, as described by Seguí et al.; thus, participants with a total score of 6 or more were defined as having CVS (13). In the absence of a universal consensus on CVS severity grading and after discussion with a multidisciplinary group of experts and an academic optometrist, we decided to adopt the following criteria: participants with a total score of 6–12 were deemed to

have mild CVS, those with a score of 13-19 were deemed to have moderate CVS, and those with a score of 20 or more were considered to have a severe CVS.

Statistical Analysis

Statistical analysis was performed using Statistical Package for Social Sciences version 25 (IBM SPSS Statistics for Windows, Armonk, NY). Descriptive statistics were calculated for all variables. Categorical variables are presented as counts and percentages. Numerical variables are presented as the mean and standard deviation if normally distributed. Univariate and multivariate analyses were carried out using nonparametric methods. The variables in the subgroups were not normally distributed. Hence, the CVS score is presented as the median and interquartile range (IQR). The CVS score was correlated with different independent demographic- and health-related variables using univariate analysis. Variables significantly correlated with the score were studied for interactions and predictors using regression analysis. The Mann-Whitney U test was used to determine if there was a statistically significant difference between two subgroups, and the Kruskal-Wallis test was used to determine if there was a statistically significant difference among more than two subgroups of independent variables. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

A total of 416 radiologists and radiology residents completed the survey. Participants ranged in age from 22 to 65, with a mean age of 35.8 ± 8.4 years. As observed in Table 1, the majority were male (65.4%). Approximately two-thirds (65.9%) were general radiologists with no subspeciality. Approximately 40% of radiologists indicated their use of visual aids such as eyeglasses and contact lenses. There were 16 (3.8%) radiologists with diabetes, 30 (7.2%) radiologists with hypertension and 12 (2.9%) radiologists with autoimmune diseases. Sixteen percent of radiologists had a history of refractive surgery. The mean number of hours spent in front of PACS monitors per week was 34.3 ± 14.6 hours. Details regarding the personal and ocular health of the participants are shown in Table 2. In addition to their occupational use of PACS monitors, most of the participants (394, 94.7%) indicated their use of other digital devices such as smartphones, laptops, and tablets. The median duration of use was 4 hours per day (IQR: 3.0; 6.0). A total of 254 (61.1%) reported that they watched television for a median of 1 hour per day (IQR: 1.0-2.7). Wall projectors were used by 24 (5.8%) radiologists.

The prevalence of CVS in our study population was 65.4% (95% CI: 60.8-70.0). The median CVS score was 7.5 (IQR: 4.0; 12.0). Only 12 (2.0%) participants had none of the 16 symptoms (total CVS-Q score = 0). Using our proposed criteria for CVS severity grading, mild CVS (total CVS-Q score ranging between 6 and 12) was observed in 188 (69.1%), moderate CVS (total CVS-Q score between 13 and 19) was observed in 69 (25.4%), and severe CVS was observed in 15 (5.5%) of those who fulfilled the criteria for CVS.

TABLE 1. Demographic Characteristics of the Participants

	Number	Percentage
Gender		
Male	272	65.4
Female	144	34.6
Experience		
<5 yrs	136	32.7
5-9.9 yrs	112	26.9
10-14.9 yrs	76	18.3
15 and more yrs	92	22.1
Rank		
Consultant	142	34.1
Senior registrar	79	19.0
Registrar	55	13.2
Resident	140	33.7
Subspeciality in radiology		
None	274	65.9
Abdominal imaging (body imaging)	23	5.5
Abdominal imaging + nonvascular Interventions	7	1.7
Breast imaging	9	2.2
Cardiac imaging	4	1.0
Emergency radiology	2	0.5
Interventional neuroradiology	17	4.1
Musculoskeletal imaging	18	4.3
Neuroradiology	14	3.4
Nuclear medicine	10	2.4
Pediatric radiology	8	1.9
Thoracic imaging	23	5.5
Vascular interventional radiology	5	1.2
Other	2	0.4

The most common ocular- and visual-related CVS symptoms perceived by participants were headache (72.1%), dryness (70.7%), burning (63.7%), blurred vision (56.3%), and increased sensitivity to light (55.5%) (Fig 1). The least commonly reported symptoms were double vision (11.3%), colored halos around objects (25.5%), heavy eyelids (31.3%), excessive blinking (32.9%), and foreign body sensation (36.1%). The severity of each ocular- and visual-related CVS symptoms perceived by the participants is shown in Figure 2.

Females had a significantly higher CVS score than males ($p < 0.001$). Additionally, participants using eyeglasses ($p = 0.003$) had significantly higher CVS scores, and radiologists spending 20 hours or less in front of the monitors per week had significantly lower CVS scores ($p = 0.002$). The correlation of the CVS score with different variables is shown in Table 3.

The multinomial regression analysis suggested that female gender ($p < 0.001$), work as a general radiologist ($p = 0.05$), and the use of eyeglasses ($p = 0.001$) were significant predictors of CVS. A comparison of the results of our study with

TABLE 2. Personal and Ocular Health of the Participants

	Number	Percentage
Smoking status		
Yes	68	16.3
No	348	83.7
Use of visual aids		
Eyeglasses	161	38.7
Contact lenses	24	5.8
No	255	61.3
History of refractive surgery		
No	348	83.7
Yes	68	16.3
Type of refractive surgery		
PRK	18	4.3
LASIK-Femto-LASIK	32	7.7
Femto-SMILE	1	0.2
Not sure	16	3.8
Date of the refractive surgery		
Less than 6 mo	3	4.4
6-12 mo	65	95.6
More than 12 mo	0	0
Number of monitors used during work		
1	43	10.3
2	180	43.3
3	174	41.8
4	19	4.6
Number of working hours per week		
Mean		34.3
Standard deviation		14.6

those of previously published studies on CVS among radiologists and other professionals is shown in Table 4.

DISCUSSION

Radiologists are susceptible to different occupational health hazards, particularly CVS, due to increased and prolonged exposure to PACS monitor (9). Our study is the first to use the reliable and validated CVS-Q survey instrument in radiologists. The CVS-Q has a reported sensitivity and specificity of 75.0% and 70.2%, respectively (13). In our study, a high prevalence of CVS among radiologists was observed. Two-thirds of participants experienced CVS, and nearly one-third of them had a score suggestive of moderate to severe CVS. A greater proportion of female radiologists than male radiologists suffered from CVS, and they were more likely to have severe grade CVS than male radiologists. This was also observed in several previous studies (7,9,11,14). A higher prevalence of myopia, better compliance with the use of visual aids and more time spent indoors than males could be responsible for the higher prevalence and worse severity of CVS among females (15-18).

The prevalence and severity of CVS among radiologists in the present study were greater than what was previously reported in the literature. In our study, the prevalence of CVS among radiologists in Saudi Arabia was 65.4%, compared to 36.0% among radiologists in North America (9). The occurrence of CVS was also higher than what was

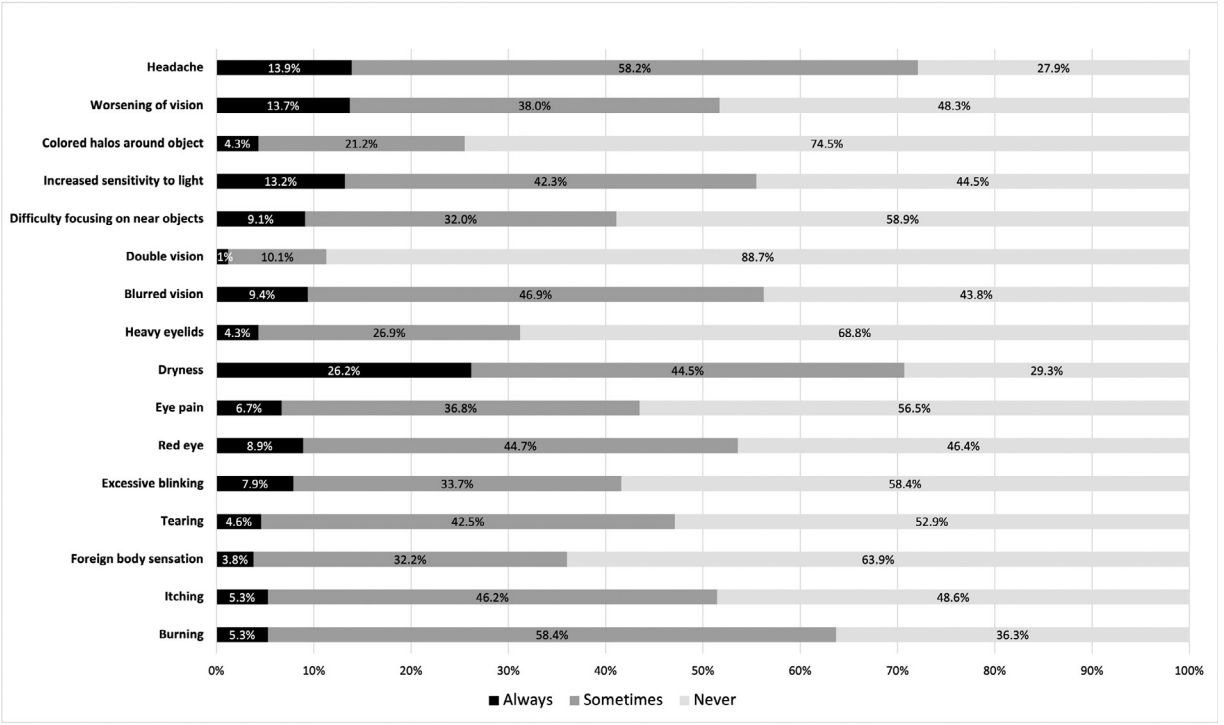

Figure 1. Frequency of ocular- and visual-related CVS symptoms perceived by the participants. CVS, computer vision syndrome.

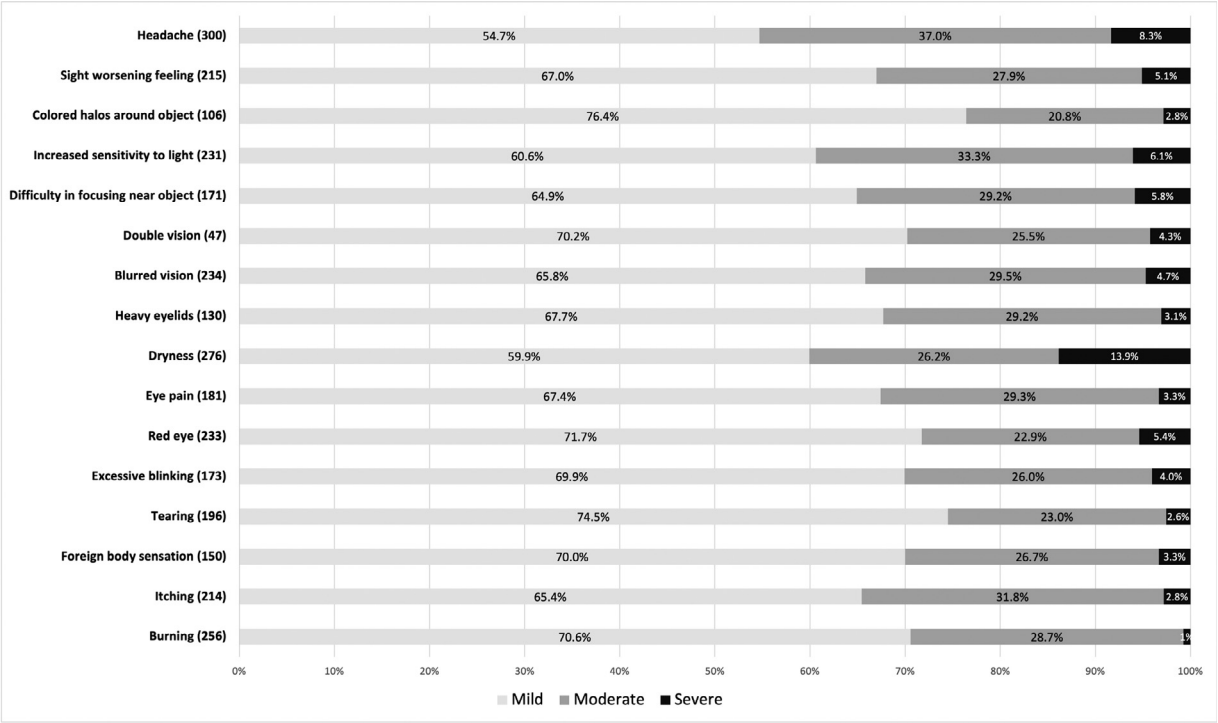

Figure 2. Severity of ocular- and visual-related CVS symptoms perceived by the participants. CVS, computer vision syndrome.

recently reported by Al Dandan et al., who reported prevalence of digital eye strain to be 50.5% among radiologists in the eastern province of Saudi Arabia (7). The difference could be attributed to the variation in the CVS measurement tools used. The prevalence of CVS in our population was in the range of what was previously reported among computer office workers, bank workers, and information technology professionals (11,19-22). Although the prevalence of CVS was high among radiologists, it is difficult to compare it with that among other professionals using computers in their daily work. The use of a uniform scoring system and perhaps an objective method of assessing CVS may be more appropriate for comparing differences in occupational hazards among different professionals (23). CVS is an occupational hazard among radiologists, and more detailed studies on risk factors using prospective study designs and objective measurement tools are recommended. This will also enable us to review the impact of remedial measures adopted to address the identified risk factors and to conduct interventional prospective research.

Long hours facing PACS monitors was a predictor of CVS and its severity in our study. Excessive exposure to computer monitors and daily usage of digital devices were among the risk factors for CVS in medical students in western Saudi Arabia (14). Taking more frequent breaks while working was found to protect radiologists from CVS-related eye strain (7,9). Radiologists should be advised to take frequent short breaks to enhance their productivity and visual well-being.

CVS encompasses a large array of symptoms. In our study, we evaluated 16 visual- and ocular-related CVS symptoms. The most commonly reported symptoms were headache, eye dryness, burning, blurred vision, and increased sensitivity to light. These symptoms were also reported as the most common symptoms in other studies on CVS in the general population during the coronavirus disease 2019 (COVID-19) lockdown, IT professionals and computer users (11,24,25). Health education and increasing awareness with regard to CVS symptoms and risk factors could be helpful in improving the visual and ocular well-being of radiologists. Ergonomic features are important in the radiology reading room. Viewing distance, height and inclination of the monitor and proper ambient light in the reading room are known factors associated with CVS (2,11,14,19).

Radiologists spend long hours in front of PACS monitors reviewing and reporting images from different imaging modalities, and thus, they share the same unavoidable occupational hazards as computer workers. Excessive exposure to monitors is an important factor that may predispose and lead radiologists to develop CVS. Policies and guidelines to minimize its occurrence were suggested by the European Agency for Safety and Health at Work (26). In Europe, radiologists are protected under legislation enacted by the European Union amended by The European Parliament (Directive 90/270/EEC), which requires employers to provide regular eye examinations and breaks during work (27).

We encounter several limitations in our study including reporting the perception of each symptom to determine the magnitude and severity of CVS instead of an objective measurement. A combination of subjective and objective measurements of CVS may have been more useful. Other

TABLE 3. Correlation of CVS Score with Different Variables

Determinant	Number	Median CVS Score	Inter Quartile Range	*p*-value
Gender				
Male	272	6.0	3.0; 10.0	<0.001
Female	144	10	6.0; 14.0	
Experience				
<5 yrs	135	7.0	4.0; 12.0	0.211
5-9.9 yrs	112	8.0	4.0; 11.0	
10-14.9 yrs	76	6.5	4.0; 11.0	
≥15 yrs	92	8.0	6.0; 139.8	
Rank level				
Consultant	142	8.0	4.0; 11.0	0.268
Senior registrar	79	7.0	3.0; 11.0	
Registrar	55	6.0	4.0; 12.0	
Resident	140	8.0	4.0; 12.8	
Specialty				
None	269	8.0	4.0; 12.0	0.057
Subspecialist	144	7.0	4.0; 10.0	
Age-group				
<35 yrs	221	7.0	4.0; 11.3	0.787
≥35 yrs	195	8.0	4.0; 12.0	
Diabetes				
Present	16	7	4.0; 14.3	0.689
Absent	399	8.0	4.0; 12.0	
Hypertension				
Present	30	7.5	4; 14.3	0.511
Absent	385	8.0	4.0; 11.0	
Use of other devices				
Smart devices	394	8.0	4.0; 12.0	0.545
TV	254	7.0	4.0; 11.0	
No TV	157	8.0	4.0; 12.0	
Smoking habit				
Yes	68	8.0	4; 12.8	0.739
No	348	7.0	4.0; 11.8	
Use of eyeglasses				
Yes	161	8.0	5.0; 13.0	0.003
No	255	7.0	4.0; 11.0	
Number of monitors used for work				
1	43	7.0	3.0; 12.0	0.671
2	180	7.7	4.0; 11.8	
3	174	7.5	4.8; 11.0	
4+	19	10	4.0; 15.0	
History of refractive surgery				
Yes	68	8.5	5.0; 11.8	0.376
No	348	7.0	4.0; 12.0	
Number of working hours on monitor per week				
20 hrs or less	195	6.0	4.0; 11.0	0.002
More than 20	221	8.0	5.0; 12.0	
Number of working hours per day				
4 or less	66	7.0	4.0; 11.0	0.691
More than 4	350	8.0	4.0; 12.0	

CVS, computer vision syndrome.

limitations include the cross-sectional design and possible self-reporting inaccuracies. In addition, the survey took place 9 months after the end of the COVID-19 pandemic lockdown. During this period, health services were negatively affected, and the workload of radiologists was relatively less than usual compared to the period before COVID-19. Subsequently, CVS might be underestimated in our study. Also, we did not collect information regarding viewing distance, height and

TABLE 4. Comparison of the Results of Our Study with Those of Previously Published Studies on Computer Vision Syndrome Among Radiologists and Other Professionals

	Authors	Year	Professionals	Prevalence of CVS	Sample Size	Remarks
1	Al Dandan et al. (7)	2021	Radiologists in eastern Saudi Arabia	50.5%	198	Female gender and not taking frequent breaks were risk factors
2	Vertinsky T et al. (9)	2005	Radiologists in North America	36%	380	Female gender, longer working hours and CT scan interpretation
3	Ransinghe P et al. (11)	2016	Computer workers of Sri Lanka	67.4%	2210	Female gender, long working hours, and eye diseases were risks for CVS
4	Abudawood et al. (14)		Medical students of Jeddah, KSA	90%	651	Female gender and dry eye disease were risk factors
5	Arumugam S et al. (21)	2014	IT professionals of Chennai, India	69.3%	179	Age, duration of work and years of work in the field were not associated with CVS
6	Assefa NL et al. (19)	2017	Bank professionals of Ethiopia	73%	304	Duration of computer work and posture were associated with CVS
7	Ranganatha SC et al. (28)	2019	Engineering students	86.7%	150	Sitting and distance form computer were linked to CVS
8	Turkistani A et al. (29)	2021	General population of Saudi Arabia	77.6%	2021	Time spent using digital devices was a factor for CVS
9	Derbew H et al. (22)	2021	Bank employee in Ethiopia	74.6%	359	Sex, age, habit of taking a break, and use of electronic materials outside work were significantly associated with CVS
10	Poudel S et al. (24)	2020	IT workers in Nepal	82.5%	263	Not taking breaks, not massaging eyes, unusual viewing distance, improper posture, computer usage for more than 10 hours per day and not being aware of CVS were significant predictors of CVS
11	Sá EC et al. (20)	2014	Computer workers in Sao Paulo, Brazil	54.6%	476	Female gender, lack of recognition at work, organization of work were associated with CVS
12	Iqbal M. et al. (30)	2021	Medical students in Egypt undergoing ophthalmologic exam	76.0%	733	Refractive errors, prolonged screen hours, screen distance close to the eyes, improper gaze angle, poor screen resolution, and screen glare were risk factors for developing CVS and influencing its severity
13	Present study	2021	Radiologists in Saudi Arabia	65.4% Severe (5.5%)	416	Female gender and use of visual aids were risk factors for CVS

CVS, computer vision syndrome.

inclination of the monitor and ambient light in the reading room, and future studies could consider including them in the questionnaire.

In conclusion, eye care is an important occupational issue. In our survey, we observed a high prevalence of CVS among radiologists. Radiologists must be educated and made aware of preventive measures and strategies that allow them to avoid developing CVS. These may include, and are not limited to, taking frequent breaks, avoiding dry eyes, maintaining adequate hydration, practicing good personal care, minimizing the use of digital devices outside of work, keeping a record of eye symptoms related to work, and undergoing a periodic

eye examination. Local and international societies need to establish and implement legislative measures to ensure the safety of radiologists, minimize the effect of CVS on their performance, and maintain their eye health.

DISCLOSURE

Authors have no conflict of interests, and the work was not supported or funded by any drug company. This study was approved by the Institutional Review Board (IRB), Taibah University (IRB number TU-20-018).

ACKNOWLEDGMENTS

The authors gratefully acknowledge the Saudi Commission for Health Sciences for sending the survey email to all practicing radiology residents and radiologists. Additionally, the authors would like to thank American Journal Experts for English language editing.

REFERENCES

1. Knechtges PM, Carlos RC. The evolving role of radiologists within the health care system. Journal of the American College of Radiology: JACR 2007; 4(9):626–635.
2. Chawla A, Lim TC, Shikhare SN, et al. Computer vision syndrome: darkness under the shadow of light. Can Assoc Radiol J 2019; 70(1):5–9.
3. Taylor-Phillips S, Stinton C. Fatigue in radiology: a fertile area for future research. Br J Radiol 2019; 92(1099):20190043.
4. Kawthalkar AS, Sequeira RA, Arya S, et al. Non-radiation occupational hazards and health issues faced by radiologists - A cross-sectional study of Indian radiologists. Indian J Radiol Imaging 2019; 29(1):61–66.
5. Blehm C, Vishnu S, Khattak A, et al. Computer vision syndrome: a review. Surv Ophthalmol 2005; 50(3):253–262.
6. Krupinski EA. Why is it important to study eyestrain in radiologists? Acad Radiol 2021; 28(8):1149–1150.
7. Al Dandan O, Hassan A, Al Shammari M, et al. Digital Eye strain among radiologists: a survey-based cross-sectional study. Acad Radiol 2021; 28(8):1142–1148.
8. Dabrowiecki A, Villalobos A, Krupinski EA. Impact of blue light filtering glasses on computer vision syndrome in radiology residents: a pilot study. J Med Imaging (Bellingham) 2020; 7(2):022402.
9. Vertinsky T, Forster B. Prevalence of eye strain among radiologists: influence of viewing variables on symptoms. AJR Am J Roentgenol 2005; 184(2):681–686.
10. Krupinski EA, Berbaum KS. Measurement of visual strain in radiologists. Acad Radiol 2009; 16(8):947–950.
11. 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.
12. Dean AG SK, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version. Available at: www.OpenEpi.com, updated 2013/04/06. Accessed August 18, 2021.
13. Seguí Mdel M, Cabrero-García J, Crespo A, et al. A reliable and valid questionnaire was developed to measure computer vision syndrome at the workplace. J Clin Epidemiol 2015; 68(6):662–673.
14. Abudawood GA, Ashi HM, Almarzouki NK. Computer vision syndrome among undergraduate medical students in King Abdulaziz University, Jeddah, Saudi Arabia. Journal of Ophthalmology 2020; 2020:2789376.
15. Chen M, Wu A, Zhang L, et al. The increasing prevalence of myopia and high myopia among high school students in Fenghua city, eastern China: a 15-year population-based survey. BMC Ophthalmology 2018; 18 (1):159.
16. Vitale S, Sperduto RD, Ferris III FL. Increased prevalence of myopia in the United States between 1971-1972 and 1999-2004. Arch Ophthalmol 2009; 127(12):1632–1639.
17. Grzybowski A, Kanclerz P, Tsubota K, et al. A review on the epidemiology of myopia in school children worldwide. BMC Ophthalmology 2020; 20(1):27.
18. Morjaria P, McCormick I, Gilbert C. Compliance and predictors of spectacle wear in schoolchildren and reasons for non-wear: a review of the literature. Ophthalmic Epidemiol 2019; 26(6):367–377.
19. Assefa NL, Weldemichael DZ, Alemu HW, et al. Prevalence and associated factors of computer vision syndrome among bank workers in Gondar City, northwest Ethiopia, 2015. Clin Optom (Auckl) 2017; 9:67–76.
20. Sa EC, Ferreira Junior M, Rocha LE. Risk factors for computer visual syndrome (CVS) among operators of two call centers in São Paulo, Brazil. Work. 2012; 41:3568–3574.
21. Arumugam S, Kumar K, Subramani R, et al. Prevalence of computer vision syndrome among information technology professionals working in Chennai. World Journal of Medical Sciences 2014; 11(3):312–314.
22. Derbew H, Nega A, Tefera W, et al. Assessment of computer vision syndrome and personal risk factors among employees of commercial bank of Ethiopia in Addis Ababa, Ethiopia. J Environ Public Health 2021; 2021:6636907.
23. Sheppard AL, Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. BMJ Open Ophthalmology 2018; 3(1):e000146.
24. Poudel S, Khanal SP. Magnitude and determinants of Computer Vision Syndrome (CVS) among IT workers in Kathmandu, Nepal. Nepal J Ophthalmol 2020; 12(24):245–251.
25. Galindo-Romero C, Ruiz-Porras A, García-Ayuso D, et al. Computer vision syndrome in the Spanish population during the COVID-19 lockdown. Optom Vis Sci 2021; 98(11):1255–1262.
26. Halpenny D, O'Driscoll D, Torreggiani WC. Ocular health among radiologists in the age of PACS: Is it time for our profession to open its eyes to this issue in light of existing European legislation? Br J Radiol 2012; 85 (1020):e1309–e1e11.
27. COUNCIL DIRECTIVE (90/270/EEC) on the minimum safety and health requirements for work with display screen equipment Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01990L0270-20190726 . Accessed August 8, 2021.
28. Ranganatha SCSJ. Prevalence and associated risk factors of computer vision syndrome among the computer science students of an engineering college of Bengaluru-A cross-sectional study. Galore International Journal of Health Sciences and Research 2019; 4(3):10–15.
29. Turkistani AN, Al-Romaih A, Alrayes MM, et al. Computer vision syndrome among Saudi population: an evaluation of prevalence and risk factors. J Family Med Prim Care 2021; 10(6):2313–2318.
30. Iqbal M, Said O, Ibrahim O, et al. Visual sequelae of computer vision syndrome: a cross-sectional case-control study. J Ophthalmol 2021; 2021:6630286.