ORIGINAL ARTICLE

Computer vision syndrome (CVS): the assessment of prevalence and associated risk factors among the students of the American University of Armenia

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Abstract

Aim Computer vision syndrome (CVS) is a major occupational threat in the twentyfirst century, leading to decreased sleep quality, reduced work efficiency, and depression. This study aimed to assess the prevalence of CVS and the associated risk factors among undergraduate students of the American University of Armenia (AUA).

Subject and methods An online survey was conducted among 143 students aged 18 years and above in June 2021. Participants provided information about their socio-demographics, health, smoking, duration of computer/video display terminal (VDT) device use, daily hours of computer use before and during the SARS-CoV-2 pandemic, and protective habits while using the computer/VDT devices. The Computer Vision Syndrome Questionnaire was used to assess the presence of CVS.

Results The mean age of participants was 19.7 (SD ± 1.37). The majority of participants were women (79.4%). Allergy was the most prevalent chronic disease in the sample (17.5%). Almost 62.2% of participants reported having refractive errors (REs). About 9.0% of the study sample were current smokers. Daily hours of computer use before and during SARS–CoV-2 pandemic were 5.5 and 10.0 respectively. Only 10.7% of participants were taking breaks every 20 minutes while using computer/VDT devices. The prevalence of CVS was 78.3%. The most commonly reported symptoms of CVS were eye redness (74.6%), headache (72.5%), itching eye (71.2%), burning eye (70.5%), tearing eye (66.7%), and blurred vision (63.4%). In the adjusted analysis, the presence of REs, sitting position, viewing distance in using the computer/VDT devices, and voluntary blinking were associated with CVS.

Conclusion This study found a high prevalence of CVS in the study population. Following the recommendations on correct sitting position and viewing distance while using computer/VDT devices might reduce the prevalence of CVS in the target population. The interventions should particularly focus on the students with REs who are disproportionately affected by CVS.

Keywords Computer vision syndrome (CVS) · Undergraduate students · Risk factors of CVS · Computer use during SARS–CoV-2

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Introduction

The great advancements in information technology and increasing use of digital devices, observed globally over the past decades, have given rise to a number of symptoms that have been termed computer vision syndrome (CVS) (Sheppard and Wolffsohn 2018; Rosenfield 2011). According to the American Optometric Association (AOA), CVS, also known as digital eye strain (DES), is a complex of eye and vision-related symptoms experienced due to sustained use of computers, laptops, smartphones, tablets, e-readers, and other digital devices, which are collectively called the devices with video display terminals (VDT) (Computer vision syndrome | AOA n.d.). CVS is one of the leading

occupational hazards of the twenty-first century, affecting about 90% of computer users (Akowuah et al. 2021; Smaldone et al. 2007; Wimalasundera 2009). Nowadays, students spend many hours in front of their computer screens. The use of computers, laptops, tablets, and other digital devices is becoming increasingly common among students in educational institutions (Cantó-Sancho et al. 2021). Wang et al. found that CVS affected 77.1% of undergraduate students and 69.1% of medical students enrolled in the University of Illinois at Chicago in 2021 (Wang et al. 2023), while Noreen and Umar found that CVS was reported in 98.7% of undergraduate students from Pakistan in 2020 (Noreen and Umar 2021). Numerous studies have investigated the prevalence of CVS and associated factors. However, most of these studies concentrated on Western populations, while no studies have explored the effect of VDT use on eye health in the Armenian population. This study aimed to assess the prevalence of CVS and explore factors contributing to it among the undergraduate students of the American University of Armenia (AUA).

The symptoms associated with CVS are grouped into four categories: 1) visual symptoms such as slowness of focus change, double vision, and blurred vision, 2) ocular surface-related symptoms such as irritated eyes, watery eyes, dry eyes, and issues with contact lens use (Akkaya et al. 2018; Iqbal et al. 2021), 3) asthenopic symptoms such as eye strain, tired eyes, glare sensitivity, and sore eyes, and 4) extra-ocular symptoms such as headache, neck pain, shoulder pain, and lower back pain (Dhar-Munshi et al. 2019; Computer vision syndrome 2022). In addition to eye health-related problems, the excessive use of computer/VDT devices has been shown to lead to other conditions, such as sleep disorders, anxiety, insomnia, stress, depression, and musculoskeletal disorders (Hakala et al. 2010; Sirajudeen et al. 2018).

Risk factors contributing to the development and worsening of the symptoms of CVS include insufficient lighting of the computer screen (such as inappropriate screen brightness/contrast, glare, and inappropriate viewing angle). Staring at screens for extended periods can cause eye strain and fatigue, leading to symptoms such as dry eyes, blurred vision, and headaches. Screens emit blue light, which may disrupt the sleep–wake cycle and contribute to CVS symptoms. Additionally, constant focusing and refocusing on-screen content can strain the eye muscles. Reduced blinking while looking at screens can lead to dry eyes and irritation. In addition, 3D screens affect accommodation and convergence abilities (Pavel et al. 2023). Other factors contributing to the worsening of the CVS symptoms include improper brightness in the working area (not sufficient illumination for employees to see their work, and improper lighting design, such as illumination levels and colour spectrum, contributing to eye strain and fatigue), long duration of the computer use,

improper viewing distances of the screen, poor or abnormal seating position, use of blue-light-emitting devices, smoking, refractive errors (REs), and some medications (COX-2 inhibitors, anti-epileptic drugs, anti-hypertensive drugs) (Sun 2010; Peragallo et al. 2013; Kozeis 2009; Ranganatha and Jailkhani 2019; Madhan 2009; Hilton et al. 2004). To reduce the CVS symptoms, the AOA recommended taking a break after every 20 minutes of work by looking at an object located at least 20 feet away for a duration of 20 seconds (Computer vision syndrome | AOA n.d.). Significant reduction of CVS symptoms can be achieved by using either spectacles or contact lenses that specifically block blue light emissions from the VDT devices (Sheppard 2018).

The SARS-CoV-2 pandemic reinforced the use of digital devices across the globe. Several studies have reported the increased use of VDT and associated issues with eye health (Peiris et al. 2020; Bahkir 2020). For example, around 68% of the undergraduate medical students in Malaysia reported that the CVS symptoms had occurred or started to become worse after the SARS-CoV-2 pandemic, when academic classes switched to online mode (Peiris et al. 2020). A study conducted among Stanford University students reported that students spent about 50.2% and 77.6% of their daytime staring at a laptop, tablet, or phone in an average week before and during SARS-CoV-2 pandemic respectively (Safranek 2020; Laurinavicius 2022).

In the last few decades, there has been a significant increase in Internet use in Armenia. According to the report published by the National Statistical Service of the Republic of Armenia, as of December 2018, 72.4% of the population has been using the Internet, a substantial increase from 0.1% recorded in 2000 (Armenia Internet Usage and Telecommunications Reports 2019). According to recent estimates, the E-participation index of Armenia was 0.5674 in 2018, which was higher than the world average E-participation index of 0.5491 in the same year, suggesting high accessibility of the Internet and digital device usage (United Nations 2018). The high accessibility of the Internet directly reflects the frequent use of computers and other VDT devices (Armenia Internet Usage and Telecommunications Reports 2019).

Methods

Study population and setting

This cross-sectional study was conducted among AUA undergraduate students aged 18 years and above. Overall, 143 out of 1,474 undergraduate students (American University of Armenia 2020–2021 Factsheet n.d.) participated in the online survey in June 2021. AUA is an international university with a student body of 2,005, located in the capital

city of Armenia, offering both graduate and undergraduate degree programs (American University of Armenia 2022).

Study instrument

A structured self-administered questionnaire was developed to collect information about participants' socio-demographic characteristics (age, gender, study program, and socio-economic status), health characteristics [medication use, presence of chronic non-communicable diseases, eye diseases, and refractive error (RE)], smoking status, seating position, and screen distance while using computer/other VDT devices, the presence of glare on the computer/other VDT device screen, lifetime duration of computer/other VDT devices use, weekly hours of computer/other VDT devices use at present, and time spent on a computer/other VDT devices daily before and during SARS-CoV-2 pandemic. Protective habits while using computer/other VDT devices such as taking breaks, wearing eyeglasses containing anti-reflecting and/or blue light filter coating, voluntary blinking, lighting condition of working area, adjusting the contrast of the computer/other VDT devices with the surrounding brightness, using an anti-glare/blue light filter for the computer/other VDT devices screen, and using lubricant eye drops were also explored.

To assess the time spent on computer/other VDT devices before and during SARS-CoV-2 pandemic restrictions, participants were asked to specify the average number of hours of computer/other VDT devices use per day before/during the restrictions which were enacted due to SARS-CoV-2 pandemic (around March/April 2020). The Computer Vision Syndrome Questionnaire (CVS-Q) was used to assess the presence of CVS among the study population. The CVS-Q questionnaire is a valid and reliable tool used to assess visual health in computer workers in both clinical trials and research studies (Seguí et al. 2015). It measured the frequency of the following 16 symptoms: burning eyes, itching eyes, feeling of a foreign body in the eyes, tearing eyes, excessive blinking, eye redness, eye pain, heavy eyelids, dryness in eyes, blurred vision, double vision, difficulty in focusing for near vision, increased sensitivity to light, colored halos around objects, feeling that sight is worsening, and headache. The response option scores ranged from zero (never) to two (often/always) (Seguí et al. 2015). If the participants reported having symptoms "occasionally," or "often/always," they were asked to rate the intensity of the symptoms, choosing between the options "moderate" (one) or "intense" (two). The frequency and intensity of a symptom were multiplied to obtain the score for each symptom. The total score summed the scores of all sixteen symptoms. If the total score was ≥ 6, the participants were categorized as having CVS (Seguí et al. 2015).

Data collection

The study team generated online survey link using the Achemer tool (https://www.alchemer.com/). The head of the AUA student council shared the link among AUA undergraduate students via e-mail, asking them to complete the questionnaire. The link was sent out on June 4; after which the student council sent weekly reminders to increase the participation rate. The database with the survey data, which did not contain any identifiers, was transferred to the SPSS statistical package after the data collection was completed.

Ethical considerations

This study obtained ethical approval from the Institutional Review Board of the American University of Armenia (Protocol #: AUA-2020-004).

Analysis

The outcome variable of interest was the presence of CVS. Frequencies and proportions along with means and standard deviations were used for the descriptive analysis. Simple and multivariable logistic regression analysis explored associations between risk factors and CVS. The multivariable analysis included all variables that were found to be associated with CVS at the $p < 0.05$ level in the simple logistic regression analysis. We used the two-sample t-test to assess the difference between daily hours of computer/other VDT devices use before and during SARS-CoV-2 pandemic among people with and without CVS. SPSS version 23.0 was used to analyse the data (SPSS inc., Chicago, IL, USA).

Results

Socio-demographic and health characteristics

The mean age of participants was 19.7 (SD = 1.4). The vast majority of participants were female (79.4%). About 51% of participants reported their family's standard of living above average. Allergy (seasonal allergy, dust allergy, pollen allergy, allergic rhinitis) was the most prevalent chronic condition in the sample (17.5%). Nearly 7.7% of respondents reported having eye diseases such as acute, chronic or allergic conjunctivitis, eye teaming disorder, amblyopia, and nystagmus. Almost 62.2% of participants reported having RE; the majority were myopic (Table 1).

CVS prevalence and symptoms

The prevalence of CVS was 78.3%. The most commonly reported CVS symptoms in our study population included

Table 1 Socio-demographic and health characteristics of the study participants

	$N = 143$
Age, years: mean (SD)	19.7 (1.4)
Gender: % (*n*)	
Male	20.6 (29)
Female	79.4 (112)
Study program: % (*n*)	
BA Business	37.4 (52)
BA English & Communications	20.1 (28)
BS Computer Science	23.7 (33)
BS Engineering Sciences	5.0 (7)
BS Data Sciences	13.7 (19)
Year of program: % (*n*)	
First	21.4 (30)
Second	27.9 (39)
Third	25.0 (35)
Fourth	25.7 (36)
Socio-economic status: % (*n*)	
Family's standard of living below average	13.8 (18)
Family's standard of living average	35.4 (46)
Family's standard of living above average	50.8 (66)
Computer vision syndrome (CVS): % (*n*)	
Yes	78.3 (101)
No	21.7 (28)
Current medication use: % (*n*)	
Yes [a]	19.1 (26)
No	80.9 (110)
Chronic non-communicable diseases: % (*n*)	
Hypertension	2.1 (3)
Thyroid disease	6.3 (9)
Allergy [b]	17.5 (25)
Chronic eye diseases [c]: % (*n*)	
Yes	7.7 (11)
No	92.3 (132)
Refractive errors: % (*n*)	62.2 (89)
Myopia	50.3 (72)
Hyperopia	4.9 (7)
Astigmatism	24.5 (35)
Using contact lens for vision: % (*n*)	
Yes	23.5 (31)
No	76.5 (101)
Smoking status: % (*n*)	
Ever smokers	3.7 (5)
Never smokers	87.5 (119)
Current smokers	8.8 (12)
Smoking allowed in the household: % (*n*)	
Yes	36.8 (50)
No	63.2 (86)

[a]medication use: vitamin D supplement, anti-allergic, anti-hypertensive, eye-lubricant, thyroxin

[b]allergies: seasonal allergy, dust allergy, pollen allergy, allergic rhinitis

[c]Acute, chronic, and allergic conjunctivitis, eye teaming disorder, amblyopia and nystagmus

eye redness (74.6%), headache (72.5%), itching eye (71.2%), burning eye (70.5%), tearing eye (66.7%) and blurred vision (63.4%) (Fig. 1).

VDT use habits and characteristics

Not positioning their face at the level of a computer screen while using computer/other VDT devices was reported by 51.5% of participants. The majority of participants (69.6%) reported viewing distance of less than 50cm between the computer/other VDT devices screen and their eyes. Only 10.7% of participants followed the habit of taking a regular break every 20 minutes while using the computer/other VDT devices. About 72% of the students reported having the habit of adjusting the screen contrast in accordance with the room brightness. The mean lifetime duration of using computer/other VDT devices was about 8.4 years (SD = 3.82), while the mean weekly hours of computer use at the present time were about 60.3 hours (SD = 25.0) (Table 2).

Daily hours of computer use significantly increased during the SARS-CoV-2 pandemic in both groups (with CVS and without CVS) (Supplementary Table 1). About 69.7% of all students reported that the frequency and intensity of the CVS symptoms increased after the restrictions due to the SARS-CoV-2 pandemic (severe lock-down) in Armenia (March–April 2020).

Simple and multivariable logistic regression analysis

In the simple logistic regression analysis, female gender, study program, the presence of RE, siting position and the viewing distance in using computer/VDT devices, weekly hours of computer/other VDT devices use in the present, the frequency of taking breaks from using computer/VDT devices and having a habit of voluntary blinking were significantly associated with the CVS (Table 3). In the adjusted model, the presence of RE (OR = 3.64 95% CI: 1.20–11.0, *p* = 0.02), inappropriate siting position (the face is not at the level of computer screen) (OR = 3.35, 95% CI: 1.10–10.2, *p* = 0.03) and the viewing distance (≤ 50 cm) (OR = 3.27, 95% CI: 1.09–9.87, *p* = 0.03) in using computer/VDT devices, and having the habit of voluntary blinking (OR = 8.73, 95% CI: 1.49–51.1, *p* = 0.02) maintained significant associations with CVS, while the effect of other factors disappeared (Table 4).

Discussion

This study assessed the prevalence of CVS and explored the factors associated with it among undergraduate students in Armenia — a country for which no information on CVS

Fig. 1 Prevalence of CVS symptoms in the study sample
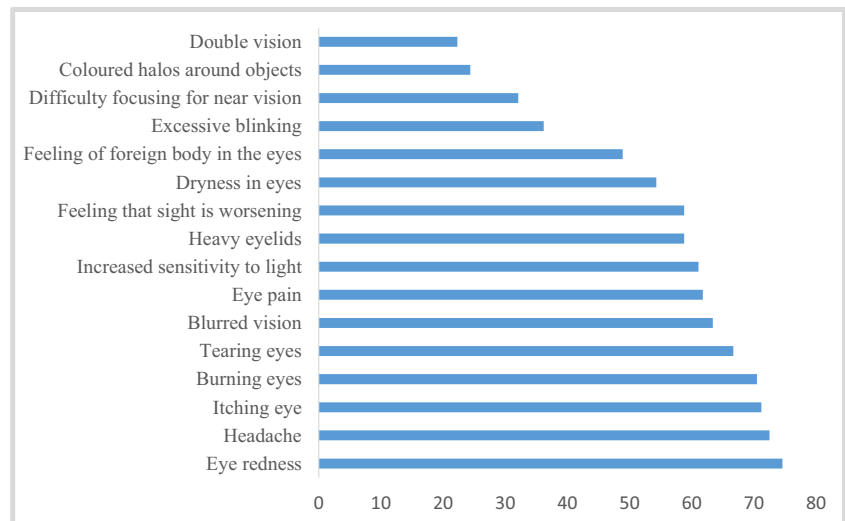
has been previously available in the literature. The rate of CVS in our study was 78.3%, which is higher when compared to most of the estimates from the studies conducted in other populations, including Spanish university students in 2020 (76.6%) (Cantó-Sancho et al. 2021), Chinese medical students during the SARS-CoV-2 pandemic in 2021 (50.8%) (Wang et al. 2021), and computer users in Ethiopia in 2022 (73.2%) (Adane et al. 2022). Our study findings are most comparable to the results of the study conducted among Indian students in 2019, where the CVS rate reached 86.7% (Gammoh 2021; Ranganatha and Jailkhani 2019). Poor knowledge and improper practice in using computer/VDT devices might explain the high CVS prevalence in our study sample. The elevated CVS prevalence in most of the countries might also be due to the timing of the study, which coincided with the SARS-CoV-2 pandemic, a period marked by widespread digitalization across every field of life.

The substantial increase in the time spent on the computer/other VDT devices as a result of SARS-CoV-2 pandemic is a concerning finding, which is in line with other reports on this topic (Peiris et al. 2020; Bahkir and Grandee 2020). This vast change in the habits of the student population (and possibly other segments of the population as well) should be mitigated by increasing awareness about the associated risks to eye health, and interventions promoting safer VDT use.

In our study, students who had REs reported a high rate of CVS, which is consistent with the literature. Muma et al., in a study conducted among students from Maseno University in Kenya in 2019, found that students, who had visual acuity < 6/18 had a higher risk for developing CVS ($p = 0.02$) than those who had normal vision (Muma et al. 2020). In the same study, students who had REs reported more symptoms of CVS compared to those who did not have REs (70% vs 24%). The presence of RE such as myopia, hyperopia, or

astigmatism increases the eyestrain while using VDT devices and further worsens the CVS symptoms (Muma et al. 2020). According to the American Academy of Ophthalmology, having slight RE abruptly exacerbates the CVS symptoms (Computer vision syndrome n.d.). We did not specifically check the presence of uncorrected refractive errors (URE) in our study, which could contribute to this association (Muma et al. 2020). Future studies should focus on the association of UREs with the CVS.

Those students who reported not having their face at the level of the screen (inappropriate sitting position) and viewing distance of ≤ 50 cm while using computer/VDT devices, had higher odds of CVS than those who reported correct practices in the adjusted analysis in our study. These findings are consistent with the literature. Adane et al. reported that CVS is significantly associated with inappropriate sitting position (the face is not at the level of computer screen and sitting in bent back position) among the computer users in Ethiopia (Adane et al. 2022). Several studies reported that a viewing distance of less than 50 cm between the eye and VDT device screen can aggravate the CVS symptoms (Jaschinski et al. 1998; Reddy et al. 2013). Boadi-Kusi et al. suggested that increasing awareness about CVS and practicing good ergonomic positions while using computers/other VDT could lessen the increasing prevalence of CVS and its burden (Boadi-Kusi et al. 2020). Improper sitting position while using computer/other VDT devices produces ocular discomfort and tension, which forces the eye to become more focused and causes a spasm of eye muscles, eventually resulting in CVS. Extended viewing of the monitor at a close distance leads to fatigue of convergence, which results in eye strain and CVS (Charpe and Kaushik 2009).

Surprisingly, voluntary blinking was associated with higher odds of CVS in the adjusted analysis in our study. Students who had a voluntary blinking habit had higher odds

Table 2 VDT use habits and characteristics

	N = 143
Sitting position in using computer/VDT devices: % (n)	
The face is at the level of computer screen	48.5 (66)
The face is not at the level of computer screen	51.5 (70)
The viewing distance in using the computer/VDT device: % (n)	
≤ 50 cm (~ < ¾ of your arm length)	69.6 (94)
> 50 cm (> ¾ of your arm length)	30.4 (41)
The presence of glare on the computer/other VDT devices screen: % (n)	
Yes	29.6 (40)
No	70.4 (95)
The duration of using computer/other VDT devices, years: mean (SD)	8.4 (3.82)
Weekly hours of computer use at the present time, hours: mean (SD)	60.4 (25.0)
Daily hours of computer use before SARS-CoV-2 pandemic, hours: mean (SD)	5.49 (2.76)
Daily hours of computer use during SARS-CoV-2 pandemic, hours: mean (SD)	10.0 (3.40)
The frequency of taking breaks using computer/other VDT devices: % (n)	
Every 20 minutes	10.7 (14)
Every 60 minutes	39.7 (52)
Every 2 hours	24.4 (32)
More than every 2 hours	25.2 (33)
Use of eye glasses: % (n)	
For computer/other VDT device use	11.7 (7)
For vision	83.3 (50)
For other purposes	5.0 (3)
Eyeglasses containing anti-reflecting and/or blue light filter coating: % (n)	
Yes	54.7 (29)
No	24.5 (13)
Do not know	20.8 (11)
Having a habit of voluntary blinking: % (n)	
Yes	27.3 (36)
No	72.7 (96)
Lighting condition of the working area: % (n)	
Very bright	4.6 (6)
Bright	40.8 (53)
Medium dull	45.4 (59)
Dull	6.9 (9)
Dark	2.3 (3)
Do you adjust the contrast of your computer/other VDT devices with the surrounding brightness?: % (n)	
Yes	71.8 (94)
No	28.2 (37)
Do you use an anti-glare / VDT filter / blue light filter for your computer screen?: % (n)	
Yes	16.7 (22)
No	83.3 (110)
Do you use lubricant eye drops while working on the computer?: % (n)	
Yes	23.3 (31)
No	76.7 (102)
How frequently do you use lubricant eye drops while working on the computer?, % (n)	
Always	3.4 (1)
Often	24.1 (7)
Sometimes	58.6 (17)
Rarely	13.8 (4)

Table 3 The results of unadjusted logistic regression analysis of factors associated with computer vision syndrome (CVS)

	OR	95% CI	P-value
Age, years: mean (SD)	0.77	0.57–1.04	0.09
Gender			
Male	1.00		
Female	4.30	1.70–10.9	0.002[*]
Study program			
BS Computer, engineering and data sciences	1.00		
BA Business	1.99	0.79–4.99	0.14
BA English & communications	4.92	1.04–23.3	0.045[*]
Year of program			
First	1.00		
Second	1.02	0.56–1.85	0.95
Third	0.84	0.57–1.25	0.40
Fourth	1.21	0.86–1.71	0.28
Socio-economic status			
Family's standard of living below average	1.00		
Family's standard of living average	0.23	0.03–1.96	0.18
Family's standard of living above average	0.28	0.03–2.29	0.23
Current medication use [a]	7.33	0.94–57.1	0.06
Chronic non-communicable diseases [b]	1.21	0.44–3.31	0.72
Chronic eye diseases [c]	2.97	0.36–24.2	0.31
Presence of refractive errors [d]	4.03	1.68–9.66	0.002[*]
Using contact lens for vision	0.31	0.09–1.12	0.07
Smoking status			
Never smokers	1.00		
Current smokers	0.31	0.09–1.11	0.07
Smoking allowed in the household	0.87	0.37–2.06	0.75
Sitting position in using computer/VDT devices			
The face is at the level of computer screen	1.00		
The face is not at the level of computer screen	2.80	1.15–6.79	0.023[*]
The viewing distance in using the computer/VDT device			
> 50 cm(> ¾ of your arm length)	1.00		
≤ 50 cm (~ < ¾ of your arm length)	3.75	1.55–9.08	0.003[*]
The presence of glare on the computer/other VDT devices screen	1.75	0.65–4.74	0.27
The duration of using computer/other VDT devices, (years)	0.89	0.79–1.01	0.06
Weekly hours of computer use at the present time, (hours)	1.03	1.004–1.05	0.017[*]
The frequency of taking breaks using computer/other VDT devices			
Every 60 minutes and less	1.00		
Every 2 hours and more	3.98	1.55–10.2	0.004[*]
Use of eye glasses for vision correction			
Used eye glasses for vision	1.00		
Not used eye glasses for vision	0.54	0.14–2.04	0.36
Eyeglasses containing anti-reflecting and/or blue light filter coating	1.13	0.09–13.6	0.93
Having a habit of voluntary blinking	6.03	1.35–27.0	0.019[*]
Lighting condition of the working area			
Very bright and bright	1.00		
Medium dull	1.07	0.45–2.56	0.88
Dull and dark	3.33	0.39–28.2	0.27
Adjusting the contrast of the computer/ other VDT devices with the surrounding brightness	1.10	0.43–2.79	0.85
Using an anti-glare/VDT filter blue light filter for the computer screen	1.21	0.37–3.95	0.75
Using lubricant eye drops while working on the computer	2.89	0.81–10.4	0.10

[a] medications use: vitamin D supplement, anti-allergic, anti-hypertensive, eye-lubricant, thyroxin

[b] hypertension, thyroid disease, allergy (seasonal allergy, dust allergy, pollen allergy, allergic rhinitis)

[c] acute, chronic and allergic conjunctivitis, eye teaming disorder, amblyopia and nystagmus

[d] myopia, hyperopia, astigmatism

[*] indicates significance

Table 4 The results of adjusted logistic regression analysis of factors associated with computer vision syndrome (CVS)

	OR	95% CI	*P*-value
Gender			
Male	1.00		
Female	1.95	0.58–6.60	0.28
Study program			
BS Computer, engineering and data sciences	1.00		
BA Business	1.43	0.45–4.51	0.54
BA English & communications	4.46	0.68–29.1	0.12
Presence of refractive errors [d]	3.64	1.20–11.0	0.022[*]
Sitting position in using computer/VDT devices			
The face is at the level of computer screen	1.00		
The face is not at the level of computer screen	3.35	1.10–10.2	0.034[*]
The viewing distance in using the computer/VDT device			
> 50 cm(> ¾ of your arm length)	1.00		
≤ 50 cm (~ < ¾ of your arm length)	3.27	1.09–9.87	0.035[*]
Weekly hours of computer use at the present time, (hours)	1.02	0.99–1.04	0.19
The frequency of taking breaks using computer/other VDT devices			
Every 60 minutes and less	1.00		
Every 2 hours and more	2.26	0.69–7.42	0.18
Having a habit of voluntary blinking	8.73	1.49–51.1	0.016[*]

[d] myopia, hyperopia, astigmatism

[*] indicates significance

of having CVS than those who did not have such a habit. Meanwhile, according to the AOA recommendations, having regular voluntary blinking habits and taking a brief pause by looking at distant objects between prolonged screen-time relaxes the eye muscles, thereby decreasing the frequency and intensity of CVS significantly (Computer vision syndrome | AOA n.d.). In contrast, Portello & Rosenfield reported that increased blinking rate did not significantly reduce CVS symptoms, even in those who have reported high score of CVS (Portello & Rosenfield 2010). Since our study was cross-sectional, it is hard to ascertain if voluntary blinking results in CVS or CVS itself leads to excessive blinking. Also, since we used a self-administered questionnaire to assess voluntary blinking, it is possible that some of the participants missed the exact meaning of the question and reported both voluntary and involuntary blinking habits. Future studies could further explore the causal link.

We would like to acknowledge several limitations. The rate of CVS in our study might be overestimated because people with CVS might have been more interested in participating in the survey than those without the symptoms. Also, since we focused on the students of one educational institution, our study findings have limited generalizability to the entire student population in Armenia, and might not be generalizable to other age groups. Another limitation of our study could be the small sample size and the use of non-validated questions for some variables.

We found a high prevalence of CVS in the study sample. Following the recommendations on the sitting position and viewing distance while using computer/VDT devices might reduce the prevalence of CVS in the student population. Public health programs increasing awareness about CVS symptoms, and following protective measures such as a proper ergonomic position while using the computer/other VDT devices and following the AOA 20–20–20 rule (taking a 20-second break to view something 20 feet away every 20 minutes) might alleviate digital eyestrain and mitigate CVS. We also recommend including people with RE (corrected and uncorrected) in such interventions and focusing on the link between RE and CVS in future investigations.

Code availability Not applicable

Declarations

Ethics approval Approval was obtained from the Institutional Review Board of the American University of Armenia. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication Not applicable

Conflicts of interest/competing interests The authors have no competing interests to declare that are relevant to the content of this article.

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