REVIEW

Prevalence of computer vision syndrome: A systematic review and meta-analysis

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Abstract
Purpose: This review aimed to estimate the prevalence of computer vision syndrome (CVS) in the general population and subgroups.
Methods: A search was conducted in the following the databases: PubMed, SCOPUS, EMBASE, and Web of Science until February 13, 2023. We included studies that assessed the prevalence of CVS in any population. The Joanna Briggs Institute's critical appraisal tool was used to evaluate the methodological quality. A meta-analysis of the prevalence of CVS was done using a random-effects model, assessing the sources of heterogeneity using subgroup and meta-regression analyses.
Results: A total of 103 cross-sectional studies with 66 577 participants were included. The prevalence of CVS was 69.0% (95% CI: 62.3 to 75.3; I^2: 99.7%), ranging from 12.1 to 97.3% across studies. Point prevalence was higher in women than in men (71.4 vs. 61.8%), university students (76.1%), Africa (71.2%), Asia (69.9%), contact lens wearers (73.1% vs. 63.8%) in studies conducted before the COVID-19 pandemic (72.8%), and in those that did not use the CVS-Q questionnaire

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(75.4%). In meta-regression, using the CVS-Q scale was associated with a lower prevalence of CVS.

Conclusion: Seven out of ten people suffer from CVS. Preventive strategies and interventions are needed to decrease the prevalence of this condition which can affect productivity and quality of life. Future studies should standardize a definition of CVS.

Introduction

In the last two decades, the usage of technological devices has rapidly increased, allowing accelerated advances in globalization, improved access to information, more significant work efficiency, and ease of communication.[1,2] However, this massive phenomenon affects the eye health of the general population by developing signs and symptoms that collectively are so-called computer vision syndrome (CVS).[3] The American Optometric Association (AOA) defines it as a set of visual disturbances resulting from prolonged use of video display terminals (VDTs), such as computers, tablets, e-readers, and cell phones.[4] CVS includes ocular symptoms such as eye fatigue, irritated/dry eyes, presbyopia, and blurred vision, among others associated with accommodation; extraocular symptoms such as the neck, shoulder, and back pain associated with posture and position for computer use.[5,6]

The prevalence of CVS is highly variable, with globally reported data ranging from 12.1% to 94.8% in the pediatric population and from 35.2% to 97.3% in the adult population.[7–10] The prevalence varies according to the evaluated demographic data (sex, age group, place of origin, occupation). CVS presents risk factors that increase the probability of developing it, such as contact lenses use, psychological stress, previous visual pathologies, use of multiple VDTs, and technological addiction problems.[11,12] Another factor that could modify prevalence is the operational definition of CVS across studies, with the Computer Vision Syndrome - questionnaire (CVS-Q)[13] being the most commonly used questionnaire. In addition, during the COVID-19 pandemic, this syndrome may have increased due to the increased use of VDTs during social isolation[14,15] and the lack of timely ophthalmologic care owing to pandemic-related consultation constraints.[16]

It is necessary to know the prevalence of CVS in the general population and how it varies according to subgroups such as sex, and method of diagnosis, among others. These data will allow us to understand the problem and identify the most affected groups to formulate prevention and treatment policies. Therefore, this systematic review with meta-analysis aimed to estimate the prevalence of CVS in the general population. Secondarily, we analyzed the prevalence by subgroups.

Material and methods

The study protocol was registered in the PROSPERO platform (CRD42022300390). The report was carried out following the Preferred Reporting Items for Systematic and Meta-Analysis (PRISMA) 2020 guidelines.[17]

Eligibility criteria

Cross-sectional and cohort studies that reported the prevalence of CVS in general population (no age or occupation restrictions) were included. Studies that defined CVS as a set of eye and vision-related symptoms resulting from prolonged use of computers, tablets, e-readers, and cell phones were incorporated. Studies that mentioned textually that they were evaluating CVS or digital eye strain were included. For the operational definition, a particular definition was not considered and studies that assessed CVS with validated (e.g., CVS-Q) and nonvalidated (e.g., at least one symptom present) methods were included. Randomized clinical trials, case-control studies, case reports, opinions, reviews, conference abstracts and studies not available in the full text were excluded.

Literature search and study selection

Searches were conducted in the following databases: 1) PubMed, 2) SCOPUS, 3) EMBASE, and 4) Web of Science/Core collection on February 13, 2023. No language or publication date restrictions were applied. For the search strategy, we used the terms: computer vision syndrome, computer visual syndrome, and digital eye strain. The complete strategy for each database can be found in supplementary material 1. In addition, we reviewed the bibliographic references of the identified reviews and contained studies to find potentially eligible studies. Duplicate articles were manually removed with Rayyan software.[18] Two authors (KGT and JNNL) independently reviewed titles and abstracts potentially eligible for selection; discrepancies were resolved with a third author (FCB). Subsequently, studies were reviewed in full-text and independently by four authors (FBC and SDCD reviewed a half, DRSM, and FCB reviewed other half) with the participation of a diriment author (DRSM) to discuss discordances and reach a consensus.

Data extraction

The interest data were extracted independently by four authors (FBC, SDCD, KGT, and JNNL) in a Microsoft Excel sheet. The discordances found were resolved with a single author (FCB). The variables of interest extracted from each study were: first author, year of publication, continent, country, study design, country income level, type of population studied (general population, children, workers, and students), the time of VDT use, the use of contact lenses,
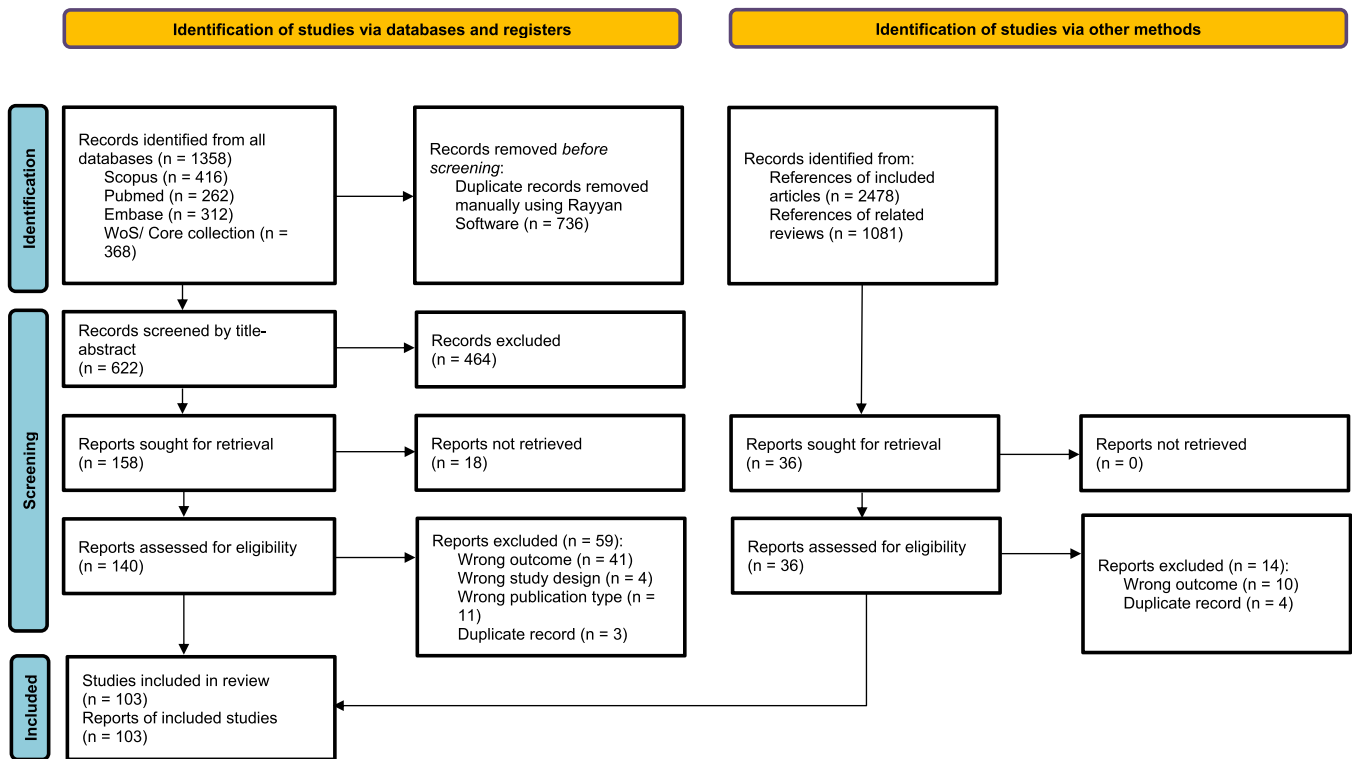
Fig. 1 Flow diagram summarizing the process of literature search and selection.

whether patients with ophthalmic pathology were excluded, whether the study was conducted during the COVID-19 pandemic, sample size, population characteristics (age and sex), symptoms included in the diagnostic criteria for CVS as well as the criteria for defining it, the prevalence in the whole population and according to sex. Data presented as median and interquartile range were converted to mean with standard deviation.

Risk of bias

Two authors (DRSM and KGT) independently assessed the methodological quality of prevalence studies using the Joanna Briggs Institute's critical appraisal tool[19,20] using Microsoft Excel software. A third author (FCB) resolved discrepancies in this process. This scale has nine items with possible responses of yes, no, and unclear. The quality score was considered as one point for yes and zero points for no and unclear. The methodological quality of the studies was classified as low risk of bias (7 or more points), moderate risk of bias (4 to 6 points), and high risk of bias (less than 4 points).

Statistical analyses

The analysis was performed with the Stata/SE version 16 program (Stata Corp, Texas, USA). Following our protocol, studies that reported the value of CVS prevalence in its study population in the meta-analysis were included. For the latter, pooled prevalences using a random-effects model were calculated, with their 95% confidence intervals calculated using the exact method. The Freeman-Tukey double arcsine transformation was used to stabilize variances. The I^2 statistic was used to assess heterogeneity and considered an $I^2 \geq 40\%$ as heterogeneity present.[21] A meta-analysis was also performed by subgroups according to sex, continent, country income level, type of population, diagnostic criteria, whether the study was performed during the COVID-19 pandemic, whether patients with ophthalmologic symptoms or diseases were included, and risk of bias. In addition, a sensitivity analysis was performed to assess the impact of articles with adequate sample sizes ($n>384$). Publication bias was evaluated through the funnel plot and statistically using Egger's test, considering as significant a $p<0.1$. Finally, as a post hoc analysis, to explore heterogeneity, a multivariate meta-regression analysis was performed to evaluate the effect of the following variables: age, sex, continent, country income level, type of population, diagnostic criteria, whether the study was performed during the COVID-19 pandemic, whether were included patients with symptoms or ophthalmologic diseases, risk of bias, publication year, mean VDTs hours of use, and% of patients with contact lenses in the study population.

Results

Study selection

After eliminating duplicates, the title and abstract of 622 articles were evaluated. From the latter, 176 studies were reviewed in full text, and 103 were finally included[7-11,15,22-118] (Fig. 1). The reasons for excluding full-text articles are given in **supplementary material 2**.

Table 1 Characteristics of the included studies (*n* = 103).

Author and publication year	Country	Population				Computer visual syndrome (CVS)		Quality score
		Target population	Sample	Female sex	Age mean (SD)	CVS-Q instrument	CVS prevalence	
Vargas-Rodríguez, 2023[66]	Colombia	University students	300	66.7%	NR	Yes	78.0%	3
Sharma, 2023[67]	India	Children and teenagers	258	45.0%	15.8 (3.9)	Yes	53.9%	4
Meneses-Claudio, 2023[68]	Peru	Workers	63	NR	NR	Yes	19.0%	3
Merhy, 2023[69]	Lebanon	Children and teenagers	389	NR	15.8 (1.9)	Yes	13.4%	6
Qolami, 2022[70]	Iran	General population	102	NR	NR	Yes	49.0%	5
Abuallut, 2022[71]	Saudi Arabia	Children and teenagers	407	51.4%	NR	Yes	35.4%	7
Shah, 2022[72]	Pakistan	Workers	127	25.2%	NR	No	79.5%	4
Wadhwani, 2022[73]	India	Children and teenagers	185	56.2%	14.2 (2)	No	29.7%	5
Munsamy, 2022[74]	South Africa	University students	290	26.2%	21 (2.3)	Yes	64.1%	6
Almousa, 2022[75]	Saudi Arabia	University students	300	58.0%	21.5 (1.9)	No	67.0%	3
Artime-Ríos, 2022[76]	Spain	Workers	622	79.1%	46.3 (10.9)	Yes	56.8%	6
Seresirikachorn, 2022[77]	Thailand	Children and teenagers	2476	64.9%	15.5 (1.7)	Yes	70.1%	4
Aldukhayel, 2022[78]	Saudi Arabia	Children and teenagers	547	49.7%	NR	Yes	69.8%	6
Cantó-Sancho, 2022[79]	Italy	Workers	241	64.3%	45.5 (11)	Yes	67.2%	6
Wangsan, 2022[80]	Thailand	University students	527	70.4%	20 (2.2)	Yes	81.0%	5
Demirayak, 2022[81]	Turkey	Children and teenagers	692	52.0%	9.7 (3)	Yes	48.0%	6
Basnet, 2022[82]	Nepal	General population	318	54.4%	36 (NR)	No	94.3%	5
Das, 2022[83]	Nepal	Workers	319	28.5%	33.4 (9.4)	No	84.3%	4
Coronel, 2022[84]	Paraguay	University students	228	71.5%	22.5 (2.6)	Yes	82.5%	5
Hailu, 2022[85]	Ethiopia	Workers	500	28.4%	30.6 (4.4)	No	78.8%	6
Girum, 2022[86]	Ethiopia	University students	812	44.1%	21 (5.2)	No	41.7%	7
Younis, 2022[87]	Saudi Arabia	Workers	451	52.1%	40 (6.5)	No	94.7%	7
Imran, 2022[88]	Saudi Arabia	University students	172	27.9%	NR	Yes	66.9%	3
Uwimana, 2022[89]	China	University students	452	34.1%	27.3 (5.6)	Yes	50.0%	7
Lotfy, 2022[90]	Egypt	University students	412	NR	22.1 (2.5)	No	88.8%	5
Chizoba, 2022[91]	Nigeria	Workers	150	54.0%	33.2 (7.2)	Yes	29.3%	7
Simanta, 2022[92]	Bangladesh	University students	917	63.0%	18,6 (3)	Yes	68.2%	7
Lindo-Cano, 2022[93]	Peru	University students	709	52.2%	22.41 (4.5)	Yes	58.3%	7
Tayyaba, 2022[94]	Pakistan	Workers	112	37.5%	25.5 (4.2)	Yes	68.8%	5
Estrada, 2022[95]	Peru	University students	215	54.9%	NR	Yes	72.1%	6
Tarun, 2022[96]	India	General population	570	NR	NR	Yes	61.9%	5
Al-Darrab, 2022[97]	Saudi Arabia	University students	521	43.8%	21.8 (2.7)	Yes	96.0%	7
Gerena, 2022[98]	Colombia	University students	296	66.6%	21.2 (2.6)	Yes	85.8%	4
Simon, 2022[99]	India	Children and teenagers	176	100.0%	14 (1)	Yes	29.5%	5
Dávila, 2021[100]	Peru	General population	700	69.3%	33.9 (NR)	Yes	63.6%	6
Mohan, 2021[22]	India	General population	217	53.5%	13 (2.5)	Yes	50.2%	4
Turki, 2021[101]	Saudi Arabia	University students	139	67.6%	NR	No	92.8%	2
Setyowati, 2021[102]	Indonesia	General population	746	67.3%	26.4 (NR)	No	79.4%	5
Huyhua, 2021[103]	Peru	University students	119	80.7%	NR	Yes	85.7%	2

Table 1 (*Continued*)

Author and publication year	Country	Population				Computer visual syndrome (CVS)		Quality score
		Target population	Sample	Female sex	Age mean (SD)	CVS-Q instrument	CVS prevalence	
Ganne, 2020[42]	India	General population	941	48.9%	23.4 (8.2)	Yes	33.2%	7
Zayed, 2021[23]	Egypt	Workers	108	63.0%	32.2 (5.1)	Yes	82.4%	3
Al Dandan, 2021[24]	Saudi Arabia	Workers	198	43.9%	NR	No	50.5%	2
Alabdulkader, 2021[11]	Saudi Arabia	General population	1939	72.3%	33.4 (12.2)	No	77.9%	5
Zalat, 2021[25]	Saudi Arabia	Workers	80	46.3%	47 (8)	Yes	81.3%	6
Wang, 2021[15]	China	University students	137	40.9%	19.2 (0.8)	Yes	63.5%	5
Gupta, 2021[26]	India	Children and teenagers	654	50.8%	12 (3.1)	No	77.5%	5
Derbew, 2021[27]	Ethiopia	Workers	351	38.5%	NR	No	74.6%	5
Boadi-Kusi, 2021[28]	Ghana	Workers	139	50.4%	24.9 (NR)	No	71.2%	7
Iqbal, 2021[29]	Egypt	University students	4030	57.9%	21.2 (1.3)	No	84.8%	8
Nikolov, 2021[30]	Bulgaria	Workers	40	22.5%	28 (0.1)	Yes	27.5%	3
Alhasan, 2021[31]	Saudi Arabia	Workers	416	34.6%	35.8 (8.4)	Yes	65.4%	6
Zenbaba, 2021[32]	Ethiopia	Workers	416	27.6%	NR	No	70.4%	5
Sánchez-Brau (a), 2021[33]	Spain	Workers	69	37.7%	54.7 (5.1)	Yes	68.1%	5
Akowuah, 2021[34]	Ghana	University students	362	55.0%	21 (1.7)	No	64.4%	7
Selvaraj, 2021[9]	India	University students	253	51.0%	NR	No	35.2%	3
Li (a), 2021[7]	China	Children and teenagers	21,966	47.2%	13.8 (2.4)	Yes	12.1%	7
Turkistani, 2021[35]	Saudi Arabia	General population	691	68.7%	33.8 (NR)	No	77.1%	4
Gammoh, 2021[36]	Jordan	University students	382	61.0%	21.5 (1.8)	Yes	94.5%	7
Fernandez-Villacorta, 2021[37]	Peru	University students	106	41.5%	34.4 (6.1)	Yes	62.3%	7
Cantó-Sancho, 2021[38]	Spain	University students	244	57.0%	20.7 (2.1)	Yes	76.6%	7
Iqbal (a), 2021[39]	Egypt	University students	733	55.7%	21.8 (1.5)	No	76.0%	5
Li (b), 2021[40]	China	Children and teenagers	2005	49.0%	12 (3)	Yes	77.0%	8
Rekha, 2021[41]	India	Children and teenagers	262	NR	13.5 (2.1)	No	41.2%	4
Qolami, 2021[104]	Iran	General population	154	64.3%	37.7 (11)	Yes	42.9%	4
Gautam, 2020[105]	Nepal	Workers	105	56.2%	27.9 (6.6)	No	92.4%	4
Rafeek, 2020[106]	India	General population	120	22.5%	21.7 (7.2)	Yes	69.2%	4
Al Tawil, 2020[43]	Saudi Arabia	University students	713	100.0%	NR	No	45.2%	5
Shrestha, 2020[44]	Nepal	General population	70	41.4%	25.6 (5.6)	No	95.7%	4
Boadi-Kusi, 2020[45]	Ghana	Workers	200	44.0%	31 (4.7)	Yes	51.5%	3
Kumar, 2020[46]	India	University students	60	50.0%	NR	No	85.0%	3
Piedrahita, 2020[47]	Argentina	General population	25	68.0%	50.1 (15.2)	Yes	52.0%	2
Arif, 2020[48]	India	Workers	50	36.0%	37.2 (7.4)	No	94.0%	4
Abudawood, 2020[49]	Saudi Arabia	University students	587	54.3%	21.7 (NR)	No	95.1%	5
Niveditha, 2020[50]	India	University students	250	51.2%	NR	No	82.4%	3
Lemma, 2020[51]	Ethiopia	Workers	455	96.7%	34.9 (8.7)	No	68.8%	5
Poudel, 2020[52]	Nepal	Workers	263	19.0%	NR	No	82.5%	4
Altalhi, 2020[10]	Saudi Arabia	University students	334	44.6%	20 (IQR: 2)*	No	97.3%	4
Sánchez-Brau (b), 2020[53]	Spain	Workers	109	43.1%	50.4 (4.8)	Yes	74.3%	6

Table 1 (*Continued*)

Author and publication year	Country	Population				Computer visual syndrome (CVS)		Quality score
		Target population	Sample	Female sex	Age mean (SD)	CVS-Q instrument	CVS prevalence	
Ranganatha, 2019[107]	India	University students	150	56.0%	20 (1.8)	No	86.7%	4
Anupama, 2019[108]	India	University students	300	56.3%	20 (2.3)	No	60.3%	3
Tesfa, 2019[109]	Ethiopia	Workers	217	100.0%	32.3 (6)	No	75.6%	4
Agbonlahor, 2019[110]	Nigeria	Workers	215	54.0%	30.4 (3.8)	No	65.6%	4
Seguí-Crespo, 2019[54]	Italy	General population	40	57.5%	35.8 (16.3)	Yes	62.5%	5
Patil, 2019[55]	India	University students	463	61.8%	19.6 (1)	No	77.5%	4
Artime Ríos, 2019[56]	Spain	Workers	343	77.3%	46.9 (10.9)	Yes	56.9%	4
Iqbal, 2018[118]	Egypt	University students	100	50.0%	NR	No	86.0%	3
Dessie, 2018[57]	Ethiopia	Workers	607	44.5%	29.6 (7.4)	No	69.5%	8
Lavin, 2018[8]	Thailand	Children and teenagers	485	55.1%	13.2 (0.9)	No	94.8%	7
Kharel, 2018[58]	Nepal	University students	236	23.7%	21.4 (1.3)	No	71.6%	5
Al Subaie, 2017[111]	Saudi Arabia	General population	416	54.1%	27.3 (10.3)	No	43.5%	6
Hassan, 2017[117]	Nigeria	Workers	305	44.9%	NR	No	90.5%	2
Assefa, 2017[59]	Ethiopia	Workers	304	34.9%	28.2 (4.6)	No	73.0%	5
Rathore, 2016[112]	India	Workers	150	46.0%	NR	No	75.3	3
Noreen, 2016[113]	Pakistan	University students	198	69.2%	20.2 (3.8)	No	67.2	3
Hassan, 2016[114]	Pakistan	University students	170	24.7%	21.1 (1.6)	No	72.4	3
Tauste, 2016[60]	Spain	Workers	426	52.1%	47.3 (8.9)	Yes	53.1%	6
Ranasinghe, 2016[61]	India	Workers	2210	49.2%	30.8 (8.1)	No	67.4%	5
Zainuddin, 2014[115]	Malaysia	Workers	146	65.8%	NR	No	63.0%	3
Arumugam, 2014[116]	India	Workers	179	NR	NR	No	69.3%	1
Logaraj, 2014[62]	India	University students	416	47.6%	NR	No	80.3%	3
Reddy, 2013[63]	Malaysia	University students	795	60.6%	21.3 (NR)	No	89.9%	5
Sa, 2012[64]	Brazil	Workers	476	74.8%	NR	No	55.5%	4
Rahman, 2011[65]	Malaysia	Workers	436	61.5%	31.5 (7.3)	No	68.1%	6

Abbreviations: CVS (Computer visual syndrome); CVS-Q (Computer Vision Syndrome Questionnaire); SD (Standard deviation); NR: not reported.
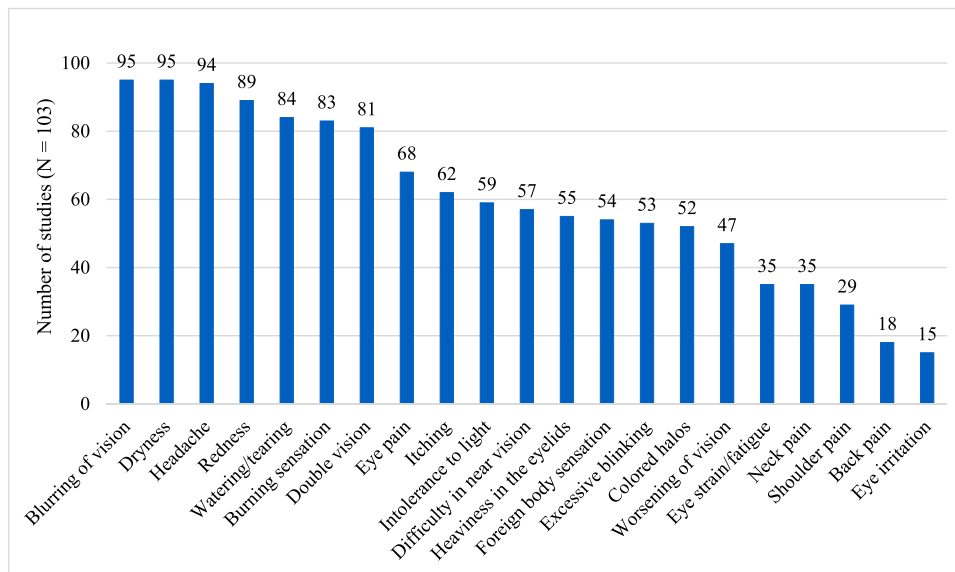*Median (interquartile range).

Fig. 2 Symptoms considered in CVS definitions.

Study characteristics

Table 1 summarizes the characteristics of the included studies. The 103 included studies were cross-sectional. The study sample size ranged from 25[47] to 21 966[7] individuals, with a total of 66 577 participants. Regarding the continent, 62 were conducted in Asia, 21 in Africa, 11 in Latin America, and 9 in Europe. The mean age of participants ranged from 9.7 to 54.7 years. Regarding populations, 37 studies evaluated workers (mainly office, informatic workers, or university workers), 38 university students, 14 children and adolescents, and the rest general population. The studies by Gerena, et al., Al Tawil et al., and Tesfa et al. included only women.[43,98,109] Forty eight studies (46.6%) were conducted during the COVID-19 pandemic. In addition, 45 (43.7%) articles excluded participants with ophthalmologic pathologies.

Diagnostic criteria

As a diagnostic method, 49 studies used the CVS-Q, which diagnoses patients with a score ≥6 points with CVS.[13] Iqbal et al. (a) used the CVS-F3 scale, which is not validated and defines CVS as the presence of at least one symptom.[29] The remaining 54 studies did not use any validated tool and defined CVS as having at least one or more symptoms. The most frequently used ophthalmologic symptoms to diagnose CVS among the studies were: blurring of vision (92%), dryness (92%), and redness (86%). In addition, some studies considered extraocular symptoms such as headache (91%), neck pain (34%), shoulder pain (28%), and back pain (17%) (Fig. 2). Other symptoms evaluated were finger pain, tired eyes, insomnia, depression, joint pain, numbness of hands, and general discomfort (see supplementary material 3). The median number of symptoms used to define CVS across studies was 12.9 (IQR: 9 to 16) symptoms.

Risk of bias

Most studies described the population adequately and measured the condition reliably for all participants. On the other hand, 38.9% did not comply with achieving an adequate sampling or having an adequate sample, which could affect the representativeness of the data. In addition, less than half (47.6%) used an adequate sampling frame (low number of studies in the community), performed an appropriate statistical analysis (25.2%), and measured CVS with validated methods (47.6%). The overall risk of bias assessment score is in Table 2, and its detailed assessment is in **supplementary material 4**.

Prevalence of CVS

When meta-analyzing the studies, the prevalence of CVS was 69.0% (95% CI: 62.2 to 75.4; I2: 99.7%), with a range between 12.1 to 97.3% across studies (Fig. 3). This result presented a high heterogeneity. In addition, the prevalence was evaluated according to sex, continent, country income, diagnostic criteria, type of population, studies conducted during the COVID-19 pandemic, the inclusion of patients with ophthalmological diseases, and level of risk of bias (Table 2). The point prevalence of CVS was higher in women than in men (71.4 Vs 61.8%). Among the four continents evaluated, Africa (71.2%) and Asia (69.9%) presented a higher prevalence than Latin America (66.6%) and Europe (60.9%). The studies that used the CVS-Q as diagnostic criteria had a lower prevalence (61.3%) than studies that used other criteria (75.4%). Regarding the type of population, the prevalence was lower in children and adolescents (50.5%) and higher in university students (76.1%). Studies conducted during the pandemic revealed a lower prevalence of CVS (64.6%). In addition, the prevalence was higher among contact lens wearers (73.1%). Despite these differences in point estimates, most results were imprecise, with overlapping confidence intervals between subgroups. Prevalence among country income subgroups, the inclusion of patients with

Table 2 Overall and subgroups prevalence of computer vision syndrome.

Subgroup	Number of studies	Prevalence (95% CI)	I^2 (%)
Overall	103	69.0 (62.2 to 75.4)	99.7
Sex			
Female	51	**71.4 (61.4 to 80.5)**	99.4
Male	48	61.8 (51.0 to 72.1)	99.3
Continent			
Asia	62	69.9 (60.5 to 78.6)	99.8
Africa	21	**71.2 (64.0 to 77.8)**	98.2
Europe	9	61.4 (54.2 to 68.3)	89.8
Latin America	11	66.6 (57.6 to 74.9)	96.1
Country income group			
Low income	8	69.3 (59.5 to 78.3)	97.5
Lower-middle income	40	**71.3 (65.2 to 77.0)**	98.6
Upper-middle income	25	66.1 (49.1 to 81.2)	99.8
High income	30	68.0 (60.3 to 75.2)	98.6
Diagnostic criteria			
CVS-Q	49	61.3 (50.7 to 71.4)	99.7
Other criteria	54	**75.4 (71.3 to 79.4)**	98.3
Type population			
General population	13	67.9 (56.7 to 78.3)	98.8
Children and adolescents	14	50.5 (29.3 to 71.6)	99.9
Workers	37	69.2 (64.7 to 73.6)	96.1
University students	38	**76.1 (70.7 to 81.2)**	98.5
Study conducted during COVID-19 pandemic			
No	55	**72.8 (67.8 to 77.5)**	98.4
Yes	48	64.6 (53.7 to 74.8)	99.8
Inclusion of patients with ophthalmological diseases			
No	58	**70.3 (65.5 to 74.8)**	98.7
Yes	45	67.3 (54.9 to 78.7)	99.8
Risk of Bias			
Low risk	19	66.0 (45.6 to 83.7)	99.9
Moderate risk	61	**70.1 (66.0 to 74.1)**	98.1
High risk	23	68.6 (61.1 to 75.6)	96.0
Use of contact lenses			
Contact lens wearers	8	**73.1 (68.1 to 78.1)**	20.5
Non-contact lens wearers	12	63.8 (52.5 to 74.3)	97.8

CI: Confidence interval; CVS-Q: Computer vision syndrome questionnaire.

ophthalmological diseases, and the risk of bias was similar **(supplementary material 5).**

Sensitivity analysis

A sensitivity analysis was performed considering only those studies with adequate samples ($N > 384$). The prevalence was found to be similar between studies with adequate (67.6%) and inadequate (70.0%) sample sizes.

Publication bias

On inspection of the funnel plot, asymmetry was found, with fewer studies to the left of the estimate. This finding was corroborated by the significance of Egger's test ($p < 0.001$). In addition, an additional sensitivity analysis was performed by eliminating the study by Li et al. (a),[7] which showed a low prevalence of CVS with a sample of 21 966 participants. In doing so, the funnel plot became more symmetric, and Egger's test was non-significant ($p = 0.122$) **(see supplementary material 6).**

Meta-regression

For meta-regression analysis, three models were ran: 1) including all variables except mean VDTs hours of use and% of patients with contact lenses (72 studies), 2) including all variables except% of patients with contact lenses (27 studies) and 3) including all variables except mean VDTs hours of use (23 studies). In model 1, use of the CVS-Q scale was associated with a lower prevalence of CVS (β: −0.158; 95% CI: −0.289 to −0.028; $p = 0.019$). No other variable was associated with CVS prevalence. The overall models explained little of the residual heterogeneity (residual I^2: model 1: 95.8%, model 2: 89.9%, model 3: 86.5%) and the variability between studies (adjusted R^2: model 1: 14.3%, model 2: 32.8%, model 3: −38.1%) **(see supplementary material 7).**

Discussion

In the present systematic review, the overall prevalence of CVS was evaluated. A total of 103 studies with a total

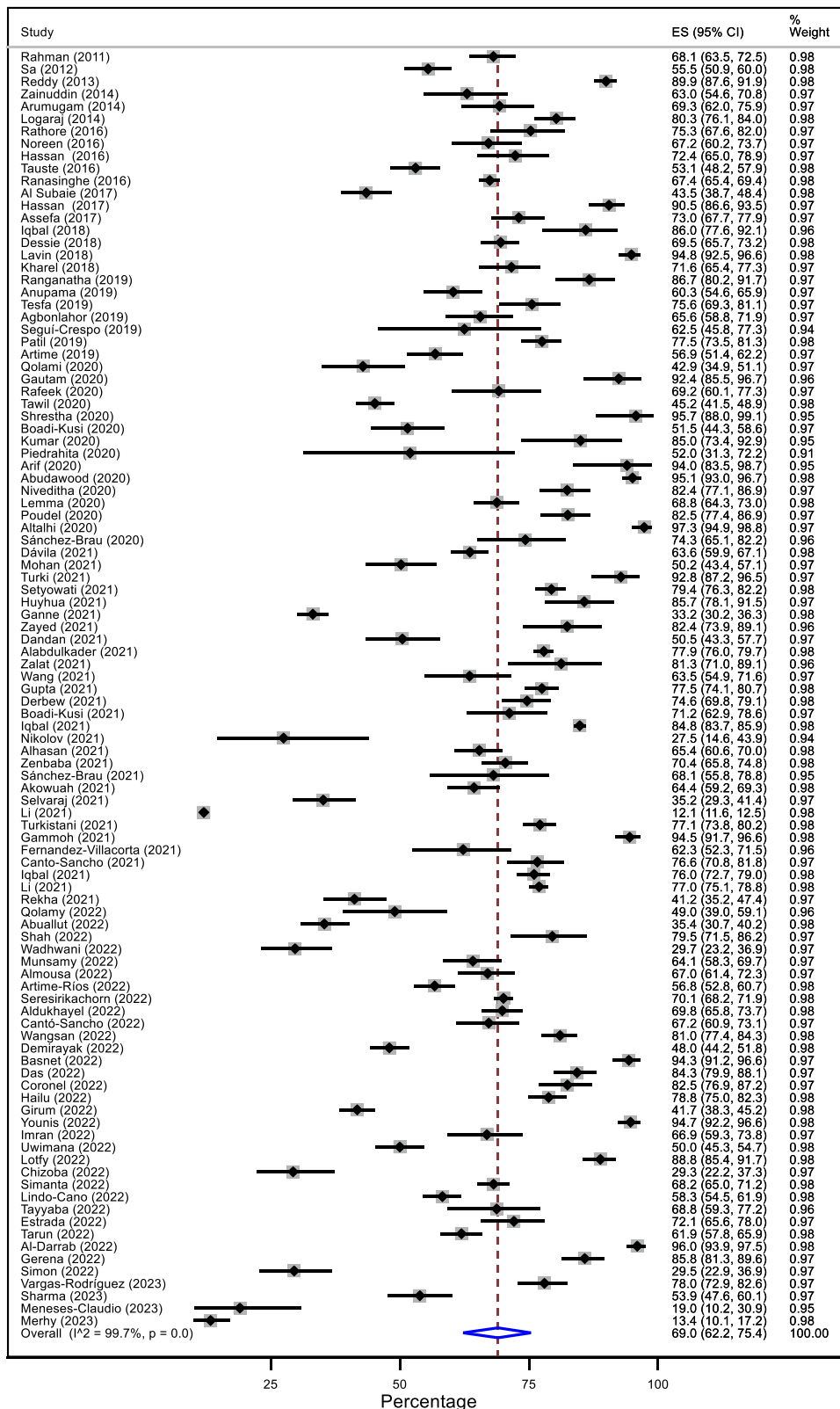| Study	ES (95% CI)	% Weight
Rahman (2011)	68.1 (63.5, 72.5)	0.98
Sa (2012)	55.5 (50.9, 60.0)	0.98
Reddy (2013)	89.9 (87.6, 91.9)	0.98
Zainuddin (2014)	63.0 (54.6, 70.8)	0.97
Arumugam (2014)	69.3 (62.0, 75.9)	0.97
Logaraj (2014)	80.3 (76.1, 84.0)	0.98
Rathore (2016)	75.3 (67.6, 82.0)	0.97
Noreen (2016)	67.2 (60.2, 73.7)	0.97
Hassan (2016)	72.4 (65.0, 78.9)	0.97
Tauste (2016)	53.1 (48.2, 57.9)	0.98
Ranasinghe (2016)	67.4 (65.4, 69.4)	0.98
Al Subaie (2017)	43.5 (38.7, 48.4)	0.98
Hassan (2017)	90.5 (86.6, 93.5)	0.97
Assefa (2017)	73.0 (67.7, 77.9)	0.97
Iqbal (2018)	86.0 (77.6, 92.1)	0.96
Dessie (2018)	69.5 (65.7, 73.2)	0.98
Lavin (2018)	94.8 (92.5, 96.6)	0.98
Kharel (2018)	71.6 (65.4, 77.3)	0.97
Ranganatha (2019)	86.7 (80.2, 91.7)	0.97
Anupama (2019)	60.3 (54.6, 65.9)	0.97
Tesfa (2019)	75.6 (69.3, 81.1)	0.97
Agbonlahor (2019)	65.6 (58.8, 71.9)	0.97
Seguí-Crespo (2019)	62.5 (45.8, 77.3)	0.94
Patil (2019)	77.5 (73.5, 81.3)	0.98
Artime (2019)	56.9 (51.4, 62.2)	0.97
Qolami (2020)	42.9 (34.9, 51.1)	0.97
Gautam (2020)	92.4 (85.5, 96.7)	0.96
Rafeek (2020)	69.2 (60.1, 77.3)	0.97
Tawil (2020)	45.2 (41.5, 48.9)	0.98
Shrestha (2020)	95.7 (88.0, 99.1)	0.95
Boadi-Kusi (2020)	51.5 (44.3, 58.6)	0.97
Kumar (2020)	85.0 (73.4, 92.9)	0.95
Piedrahita (2020)	52.0 (31.3, 72.2)	0.91
Arif (2020)	94.0 (83.5, 98.7)	0.95
Abudawood (2020)	95.1 (93.0, 96.7)	0.98
Niveditha (2020)	82.4 (77.1, 86.9)	0.97
Lemma (2020)	68.8 (64.3, 73.0)	0.98
Poudel (2020)	82.5 (77.4, 86.9)	0.97
Altalhi (2020)	97.3 (94.9, 98.8)	0.97
Sánchez-Brau (2020)	74.3 (65.1, 82.2)	0.96
Dávila (2021)	63.6 (59.9, 67.1)	0.98
Mohan (2021)	50.2 (43.4, 57.1)	0.97
Turki (2021)	92.8 (87.2, 96.5)	0.97
Setyowati (2021)	79.4 (76.3, 82.2)	0.98
Huyhua (2021)	85.7 (78.1, 91.5)	0.97
Ganne (2021)	33.2 (30.2, 36.3)	0.98
Zayed (2021)	82.4 (73.9, 89.1)	0.96
Dandan (2021)	50.5 (43.3, 57.7)	0.97
Alabdulkader (2021)	77.9 (76.0, 79.7)	0.98
Zalat (2021)	81.3 (71.0, 89.1)	0.96
Wang (2021)	63.5 (54.9, 71.6)	0.97
Gupta (2021)	77.5 (74.1, 80.7)	0.98
Derbew (2021)	74.6 (69.8, 79.1)	0.98
Boadi-Kusi (2021)	71.2 (62.9, 78.6)	0.97
Iqbal (2021)	84.8 (83.7, 85.9)	0.98
Nikolov (2021)	27.5 (14.6, 43.9)	0.94
Alhasan (2021)	65.4 (60.6, 70.0)	0.98
Zenbaba (2021)	70.4 (65.8, 74.8)	0.98
Sánchez-Brau (2021)	68.1 (55.8, 78.8)	0.95
Akowuah (2021)	64.4 (59.2, 69.3)	0.98
Selvaraj (2021)	35.2 (29.3, 41.4)	0.97
Li (2021)	12.1 (11.6, 12.5)	0.98
Turkistani (2021)	77.1 (73.8, 80.2)	0.98
Gammoh (2021)	94.5 (91.7, 96.6)	0.98
Fernandez-Villacorta (2021)	62.3 (52.3, 71.5)	0.96
Canto-Sancho (2021)	76.6 (70.8, 81.8)	0.97
Iqbal (2021)	76.0 (72.7, 79.0)	0.98
Li (2021)	77.0 (75.1, 78.8)	0.98
Rekha (2021)	41.2 (35.2, 47.4)	0.97
Qolamy (2022)	49.0 (39.0, 59.1)	0.96
Abuallut (2022)	35.4 (30.7, 40.2)	0.97
Shah (2022)	79.5 (71.5, 86.2)	0.97
Wadhwani (2022)	29.7 (23.2, 36.9)	0.97
Munsamy (2022)	64.1 (58.3, 69.7)	0.97
Almousa (2022)	67.0 (61.4, 72.3)	0.97
Artime-Ríos (2022)	56.8 (52.8, 60.7)	0.98
Seresirikachorn (2022)	70.1 (68.2, 71.9)	0.98
Aldukhayel (2022)	69.8 (65.8, 73.7)	0.98
Cantó-Sancho (2022)	67.2 (60.9, 73.1)	0.97
Wangsan (2022)	81.0 (77.4, 84.3)	0.98
Demirayak (2022)	48.0 (44.2, 51.8)	0.98
Basnet (2022)	94.3 (91.2, 96.6)	0.97
Das (2022)	84.3 (79.9, 88.1)	0.97
Coronel (2022)	82.5 (76.9, 87.2)	0.97
Hailu (2022)	78.8 (75.0, 82.3)	0.98
Girum (2022)	41.7 (38.3, 45.2)	0.98
Younis (2022)	94.7 (92.2, 96.6)	0.98
Imran (2022)	66.9 (59.3, 73.8)	0.97
Uwimana (2022)	50.0 (45.3, 54.7)	0.98
Lotfy (2022)	88.8 (85.4, 91.7)	0.98
Chizoba (2022)	29.3 (22.2, 37.3)	0.97
Simanta (2022)	68.2 (65.0, 71.2)	0.98
Lindo-Cano (2022)	58.3 (54.5, 61.9)	0.98
Tayyaba (2022)	68.8 (59.3, 77.2)	0.96
Estrada (2022)	72.1 (65.6, 78.0)	0.97
Tarun (2022)	61.9 (57.8, 65.9)	0.98
Al-Darrab (2022)	96.0 (93.9, 97.5)	0.98
Gerena (2022)	85.8 (81.3, 89.6)	0.97
Simon (2022)	29.5 (22.9, 36.9)	0.97
Vargas-Rodríguez (2023)	78.0 (72.9, 82.6)	0.97
Sharma (2023)	53.9 (47.6, 60.1)	0.97
Meneses-Claudio (2023)	19.0 (10.2, 30.9)	0.95
Merhy (2023)	13.4 (10.1, 17.2)	0.98
Overall (I^2 = 99.7%, p = 0.0)	69.0 (62.2, 75.4)	100.00

Fig. 3   Prevalence of computer vision syndrome.

of 66 577 participants were included. Most studies were in Asia and workers or university students. In general, seven out of ten people presented CVS but with heterogeneous results across studies. Point prevalence was higher in women, university students, in Asian and African populations, in studies that did not use a validated instrument, in studies that were not realized during the COVID-19 pandemic, and in contact lens wearers. In meta-

regression using a validated instrument was associated with CVS prevalence.

A systematic review with a search date of november 2021[119] found that the prevalence of CVS in Ethiopia (Africa) was 73.2% (95% CI: 70.3 to 76.1). This result is similar to the meta-analysis of our study, as generally estimated, and by the Africa region subgroup, with 71.2% CVS prevalence (95% CI: 64.0 to 77.8). However, our overall results had a very heterogeneous prevalence, varying from 12.1 to 97.3%; it may be due to the different populations considered as not all are exposed to the same risk factors for CVS as personal, environmental, and ergonomic factors during the VDTs usage.[120] In addition, the eligibility criteria for participants varied considerably.

Regarding the definition of CVS, it was observed that most studies used a wide variety of symptoms, and it is not clear which symptoms to consider to define this syndrome and how many symptoms at least would be necessary. One of the first reviews in the area[121] categorized symptoms into groups: asthenopic, ocular surface related, visuals, extra-ocular, and transient blindness. Most of these symptoms were used as diagnostic criteria in the studies included in our review. It should be noted that in the meta-analysis carried out by Adane et al.,[119] the top three symptoms reported by participants with CVS were blurred vision (34.3%), eye fatigue (32.1%), and watery eyes (30.6%). The only validated scale we found to measure this condition was the CVS-Q, which reported a lower prevalence in the subgroup and meta-regression analyses. The criteria to define CVS are not clarified in the literature, and having a standardized one is essential to propose future treatments.[13,79,122−124] Furthermore, it is important to mention that some authors argue that subjective questionnaires without an ophthalmic exam are not ideal for documenting the true prevalence of CVS.[39] In the review, we only identified one study that included evaluation by an ophthalmologist as a criterion.[39]

Regarding the prevalence by sex, we found that CVS was more frequent in females, similar to the reported in most previous studies of CVS. The latter was founded in other similar ocular pathologies in VDT users as dry eye disease[121,125,126] and ergonomics-related problems such as musculoskeletal disorders.[127] It could be because women are more likely to use VDTs than men in some populations,[97] and the conditions of use, such as ergonomics, are also often different for men and women.[128]

Regarding the type of population, a higher prevalence of CVS was found in university students (76.1%). A review published in 2020[129] on sedentary lifestyle in university students found that 72.9% of 2574 participants were in front of the screen (computer, television, and video games) for at least 2 h a day. Additionally, the computer and television were the most used VDTs, possibly representing a risk factor that would increase the prevalence in this population.[129] Regarding workers, a CVS prevalence of 69.2% was found. A previous systematic review found that the prevalence was higher in bank-working personnel (73.8%).[119] However, in the present research was not possible to establish a subgroup related to the work type, so the estimates for the different professions could be different.

The COVID-19 pandemic led millions of students and workers to continue their activities virtually, thus considerably increasing their exposure to VDTs.[130] In this context, studies carried out during the pandemic are expected to present a higher prevalence of CVS. However, in the present review, a paradoxical finding was found since the prevalence was lower in the studies carried out during the pandemic. It could be due to the fact that while the time of VDT use increased, the conditions of its use during the lockdown were different. For example, in the case of workers, the lack of breaks in an office environment compared to devices usage at home during confinement and office ergonomics could also be involved.[131] Nevertheless, there is no clear explanation for this finding.

Finally, a higher prevalence of CVS was observed in contact lens wearers.[60] The presence of a contact lens on the ocular surface can cause tear alterations and can even cause discomfort in the adjacent areas such as the cornea, conjunctiva, and eyelids.[60] This can vary depending on the material of the lenses and the conditions in which they are used such in wearers of conventional hydrogel and silicone hydrogel contact lenses.[60] Therefore, it is recommended that contact lens wearers be considered as a risk group for developing CVS, and that they should be provided with a more exhaustive follow-up of their visual health.

The included studies have several limitations since the populations are heterogeneous since were considered various eligibility criteria, age groups, and occupations. Most studies were performed in Asia and Africa, so likely our results cannot be extrapolated to other populations. The high heterogeneity in the symptoms and criteria for defining CVS was also a limitation since most studies did not use a validated instrument. Other studies had different cut-off points, regardless of utilizing the same measurement instrument. Lastly, because some studies did not use appropriate sampling techniques or adequate sample size, so the internal validity of their results is questionable.

The present systematic review shows that the prevalence of CVS is high overall. In addition, some populations were identified that may have a higher prevalence. The relevance of these findings is that this trouble can cause a reduction in work/study productivity while reducing the computer user's quality of life.[61] Thus, there is a need to investigate treatments and measures for this syndrome. However, a recent systematic review did not find high certainty evidence regarding some actions proposed as blue light filtering glasses and nutritional supplements to treat CVS-related symptoms.[122] Besides, studies are needed to see the effectiveness of other proposed measures such as artificial tears, ergonomic optimization, adequate lighting, and frequent breaks to reduce CVS.[121] It is relevant because, in the current context, the increased use of VDTs in people's lives and work will be inevitable.[132] Given the low certainty of evidence on treatments, prevention becomes more important, emphasizing risk factors and promoting health in the most affected groups like university students or women. In this sense, it has been noticed that more knowledge of ergonomic practices and improving ergonomic conditions during VDT use are associated with a lower CVS prevalence.[61]

It is recommended that future studies employ validated scales to measure CVS. Also, it is recommended to use random sampling with a detailed description of the population (age, sex, type of population) and variables associated with CVS symptoms such as duration of VDT use, devices studied (computers, smartphones, others), or ergonomic and

environmental factors. In addition, it is recommended to conduct further studies in regions such as America and Europe.

This systematic review has the following limitations: no search was done for studies in grey literature and could have excluded studies from some regions or specific populations. In addition, other factors that could explain the heterogeneity were not measured. Likewise, subgroup results should be interpreted with caution, as they are generally imprecise. However, the strengths of this review are that an exhaustive search in several databases was elaborated, and the references of the included studies were reviewed, finding a significant number of investigations. In addition, a large sample size was obtained, and subgroup and meta-regression analyses were performed to explore heterogeneity sources. Although, the high heterogeneity could not be explained by the variables proposed.

Conclusions

In conclusion, the prevalence of CVS overall was 69.0%, Point prevalences show that women, university students, populations from Asia and Africa may be more affected by this syndrome, and contact lens wearers. Point prevalence was also higher in studies conducted before the COVID-19 pandemic and that did not use a validated instrument. Preventive strategies and interventions to decrease the prevalence of this syndrome are recommendable, especially in the most affected populations. More studies using validated scales are needed to standardize the definition of CVS.

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Conflicts of interest

The authors report no commercial or proprietary interest in any product or concept discussed in this article.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.optom.2023.100482.

References

1. Calixte R, Rivera A, Oridota O, Beauchamp W, Camacho-Rivera M. Social and demographic patterns of health-related internet use among adults in the united states: a secondary data analysis of the health information national trends survey. *Int J Environ Res Public Health*. 2020;17(18):6856.
2. Zeng B, Rivadeneira NA, Wen A, Sarkar U, Khoong EC. The impact of the COVID-19 pandemic on internet use and the use of digital health tools: secondary analysis of the 2020 health information national trends survey. *J Med Internet Res*. 2022;24(9):e35828.
3. Jaiswal S, Asper L, Long J, Lee A, Harrison K, Golebiowski B. Ocular and visual discomfort associated with smartphones, tablets and computers: what we do and do not know. *Clin Exp Optom*. 2019;102(5):463−477.
4. American Optometric Association. *Computer vision syndrome*. 2022. Available from: https://www.aoa.org/healthy-eyes/eye-and-vision-conditions/computer-vision-syndrome?sso=y.
5. Munshi S, Varghese A, Dhar-Munshi S. Computer vision syndrome-A common cause of unexplained visual symptoms in the modern era. *Int J Clin Pract*. 2017;71(7):e12962.
6. Portello JK, Rosenfield M, Bababekova Y, Estrada JM, Leon A. Computer-related visual symptoms in office workers. *Ophthalmic Physiol Opt*. 2012;32(5):375−382.
7. Li L, Zhang J, Chen M, Li X, Chu Q, Jiang R, et al. Contribution of total screen/online-course time to asthenopia in children during COVID-19 pandemic via influencing psychological stress. *Front Public Health*. 2021;9: 736617.
8. Lavin W, Taptagaporn S, Khruakhorn S, Kanchanaranya N. Prevalence and associated risk factors of digital eye strain among children in secondary schools in Pathumthani Province, Thailand. *J Med Assoc Thai*. 2018;101:957−963.
9. Selvaraj S, Ganesan DK, Jain T. A study on single versus multiple symptoms of computer vision syndrome (CVS) among engineering students in kancheepuram district. *Tamil Nadu. IJCRR.*. 2021;13(06):51−55.
10. Altalhi A, Khayyat W, Khojah O, Alsalmi M, Almarzouki H. Computer vision syndrome among health sciences students in Saudi Arabia: prevalence and risk factors. *Cureus*. 2020;12(2): e7060.
11. Alabdulkader B. Effect of digital device use during COVID-19 on digital eye strain. *Clin Exp Optom*. 2021;104(6):698−704.
12. Tangmonkongvoragul C, Chokesuwattanaskul S, Khankaeo C, Punyasevee R, Nakkara L, Moolsan S, et al. Prevalence of symptomatic dry eye disease with associated risk factors among medical students at Chiang Mai University due to increased screen time and stress during COVID-19 pandemic. *PLoS One*. 2022;17(3): e0265733.
13. Seguí M del 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 Clin Epidemiol*. 2015;68(6):662−673.
14. Bhattacharya S, Saleem SM, Singh A. Digital eye strain in the era of COVID-19 pandemic: an emerging public health threat. *Indian J Ophthalmol*. 2020;68(8):1709−1710.
15. Wang L, Wei X, Deng Y. Computer vision syndrome during SARS-CoV-2 outbreak in University students: a comparison between online courses and classroom lectures. *Front Public Health*. 2021;9: 696036.
16. Vargas-Peirano M, Navarrete P, Díaz T, Iglesias G, Hoehmann M. Care of ophthalmological patients during the COVID-19 pandemic: a rapid scoping review. *Medwave*. 2020;20(4):e7902.
17. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71.
18. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan−a web and mobile app for systematic reviews. *Syst Rev*. 2016;5(1):210.
19. Migliavaca CB, Stein C, Colpani V, Munn Z, Falavigna M. Prevalence estimates reviews − systematic review methodology group (PERSyst). Quality assessment of prevalence studies: a systematic review. *J Clin Epidemiol*. 2020;127:59−68.
20. Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and cumulative incidence data. *Int J Evid Based Healthc*. 2015;13(3):147−153.

21. Morton SC, Murad MH, O'Connor E, Lee CS, Booth M, Vander-meer BW, et al. *Quantitative Synthesis-An Update*. Agency for Healthcare Research and Quality (AHRQ); 2018. Available from: https://effectivehealthcare.ahrq.gov/topics/methods-quantitative-synthesis-update/methods.

22. Mohan A, Sen P, Shah C, Jain E, Jain S. Prevalence and risk factor assessment of digital eye strain among children using online e-learning during the COVID-19 pandemic: digital eye strain among kids (DESK study-1). *Indian J Ophthalmol*. 2021;69(1):140−144.

23. Zayed HAM, Saied SM, Younis EA, Atlam SA. Digital eye strain: prevalence and associated factors among information technology professionals, Egypt. *Environ Sci Pollut Res Int*. 2021;28(20):25187−25195.

24. Al Dandan O, Hassan A, Al Shammari M, Al Jawad M, Alsaif HS, Alarfaj K. Digital eye strain among radiologists: a survey-based cross-sectional study. *Acad Radiol*. 2021;28(8):1142−1148.

25. Zalat M, Amer S, Wassif G, El Tarhouny S, Mansour T. Computer vision syndrome, visual ergonomics and amelioration among staff members in a saudi medical college. *Int J Occup Saf Ergon*. 2021;28:1−22.

26. Gupta R, Chauhan L, Varshney A. Impact of E-schooling on digital eye strain in coronavirus disease era: a survey of 654 students. *J Curr Ophthalmol*. 2021;33(2):158−164.

27. Derbew H, Nega A, Tefera W, Zafu T, Tsehaye K, Haile K, 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; 2021:1−8.

28. Boadi-Kusi SB, Adueming POW, Hammond FA, Antiri EO. Computer vision syndrome and its associated ergonomic factors among bank workers. *Int J Occup Saf Ergon*. 2022;28(2):1219−1226.

29. Iqbal M, Elzembely H, El-Massry A, Elgharib M, Assaf A, Ibrahim O, et al. Computer vision syndrome prevalence and ocular sequelae among medical students: a university-wide study on a marginalized visual security issue. *Open J Ophthalmol*. 2021;15:156−170.

30. Nikolov PN. Computer vision syndrome: review and methods for assessment. *JofIMAB*. 2021;27(2):3823−3825.

31. Alhasan AS, Aalam WA. Magnitude and determinants of computer vision syndrome among radiologists in Saudi Arabia: a national survey. *Acad Radiol*. 2021 S1076633221004967.

32. Zenbaba D, Sahiledengle B, Bonsa M, Tekalegn Y, Azanaw J, Kumar Chattu V. Prevalence of computer vision syndrome and associated factors among instructors in Ethiopian universities: a web-based cross-sectional study. Mansour A, editor. *Sci World J*. 2021;2021:1−8.

33. Sánchez-Brau M, Domenech-Amigot B, Brocal-Fernández F, Seguí-Crespo M. Computer vision syndrome in presbyopic digital device workers and progressive lens design. *Ophthalmic Physiol Opt*. 2021;41(4):922−931.

34. Akowuah PK, Nti AN, Ankamah-Lomotey S, Frimpong AA, Fummey J, Boadi P, et al. Digital device use, computer vision syndrome, and sleep quality among an African undergraduate population. *Adv Public Health*. 2021;2021:1−7.

35. Turkistani AN, Al-Romaih A, Alrayes MM, Al Ojan A, Al-Issawi W. Computer vision syndrome among Saudi population: an evaluation of prevalence and risk factors. *J Family Med Prim Care*. 2021;10(6):2313−2318.

36. Gammoh Y. Digital eye strain and its risk factors among a university student population in jordan: a cross-sectional study. *Cureus*. 2021;13(2):e13575.

37. Fernandez-Villacorta D, Soriano-Moreno AN, Galvez-Olortegui T, Agui-Santivañez N, Soriano-Moreno DR, VA Benites-Zapata. Computer visual syndrome in graduate students of a private university in Lima, Perú. *Arch Soc Esp Oftalmol (Engl Ed)*. 2021. S0365-6691(21)00005-8.

38. Cantó-Sancho N, Sánchez-Brau M, Ivorra-Soler B, Seguí-Crespo M. Computer vision syndrome prevalence according to individual and video display terminal exposure characteristics in Spanish university students. *Int J Clin Pract*. 2021;75(3):e13681.

39. Iqbal M, Said O, Ibrahim O, Soliman A. Visual sequelae of computer vision syndrome: a cross-sectional case-control study. *J Ophthalmol*. 2021;2021: 6630286.

40. Li R, Ying B, Qian Y, Chen D, Li X, Zhu H, et al. Prevalence of self-reported symptoms of computer vision syndrome and associated risk factors among school students in china during the COVID-19 pandemic. *Ophthalmic Epidemiol*. 2022;29(4):363−373.

41. Recka RS. The impact of online classes on ocular health in school children during the COVID-19 pandemic. *JMSCR*. 2021;09(10):116−123.

42. Ganne P, Najeeb S, Chaitanya G, Sharma A, Nagesha C. Digital eye strain epidemic amid COVID-19 pandemic − a cross-sectional survey. *Ophthalmic Epidemiol*. 2021;28(4):285−292.

43. Al Tawil L, Aldokhayel S, Zeitouni L, Qadoumi T, Hussein S, Ahamed SS. Prevalence of self-reported computer vision syndrome symptoms and its associated factors among university students. *Eur J Ophthalmol*. 2020;30(1):189−195.

44. Shrestha P, Pradhan PMS, Malla OK. Computer vision syndrome among patients attending the outpatient department of ophthalmology in a tertiary care centre: a descriptive cross-sectional study. *JNMA J Nepal Med Assoc*. 2020;58(230):721−724.

45. Boadi-Kusi SB, Abu SL, GO Acheampong, Adueming POW, Abu EK. Association between poor ergophthalmologic practices and computer vision syndrome among university administrative staff in Ghana. *J Environ Public Health*. 2020;2020: 7516357.

46. Kumar BS. A Study to evaluate the knowledge regarding computer vision syndrome among medical students. *Biomed Pharmacol J*. 2020;13(1):469−473.

47. Piedrahita L, Rodriguez R. Síndrome visual informático en pacientes con enfermedades crónicas relacionadas con el uso de pantallas de visualización de datos intra y extra laboral: estudio de caso. *Rev Salud Pública (Córdoba)*. 2020;24(2):50−56.

48. Arif S, Tulsani J, Naqvi S, Sharma K. Computer vision syndrome among computer operators working at a tertiary care hospital - a study of prevalence, knowledge, ergonomics and other associated factors. *JEMDS*. 2020;9(51):3856−3861.

49. Abudawood G, Ashi H, Almarzouki N. Computer vision syndrome among undergraduate medical students in King Abdulaziz University, Jeddah, Saudi Arabia. *J Ophthal*. 2020;2020:1−7.

50. Niveditha KP, Dheepak SM. Digital vision syndrome (DVS) among medical students during Covid-19 pandemic curfew. *Int J Pharm Sci Res*. 2020;11:1123−1133.

51. Lemma MG, Beyene KG, Tiruneh MA. Computer vision syndrome and associated factors among secretaries working in ministry offices in Addis Ababa. *Ethiopia. Clin Optom (Auckl)*.. 2020;12:213−222.

52. Poudel S, Khanal S. Magnitude and determinants of computer vision syndrome (CVS) among IT workers in Kathmandu, Nepal. *Nepal J Ophthalmol*.. 2020;12(2):245−251.

53. Sánchez-Brau M, Domenech-Amigot B, Brocal-Fernández F, Quesada-Rico JA, Seguí-Crespo M. Prevalence of computer vision syndrome and its relationship with ergonomic and individual factors in presbyopic VDT workers using progressive addition lenses. *Int J Environ Res Public Health*. 2020;17(3):1003.

54. Seguí-Crespo M del M, Cantó Sancho N, Ronda E, Colombo R, Porru S, Carta A. Traduzione e adattamento culturale del Questionario per lo studio della Sindrome da Visione al Computer (CVS-Q©) in italiano. *Med Lav*. 2019;110(1):37−45.

55. Patil A, Bhavya Chaudhury S, Srivastava S. Eyeing computer vision syndrome: awareness, knowledge, and its impact on sleep quality among medical students. *Ind Psychiatry J.* 2019;28(1):68−74.

56. Artime Ríos EM, Sánchez Lasheras F, Suárez Sánchez A, Iglesias-Rodríguez FJ, Seguí Crespo M del M. Prediction of computer vision syndrome in health personnel by means of genetic algorithms and binary regression trees. *Sensors (Basel).* 2019;19 (12):2800.

57. Dessie A, Adane F, Nega A, Wami SD, Chercos DH. Computer vision syndrome and associated factors among computer users in Debre Tabor Town, Northwest Ethiopia. *J Environ Public Health.* 2018;2018: 4107590.

58. Khatri A, Kharel (Sitaula) R. Knowledge, attitude and practice of computer vision syndrome among medical students and its impact on ocular morbidity. *J Nepal Health Res Counc.* 2018;16(3):291−296.

59. Assefa NL, Weldemichael DZ, Alemu HW, Anbesse DH. Prevalence and associated factors of computer vision syndrome among bank workers in Gondar City, northwest Ethiopia, 2015. *Clin Optom (Auckl).* 2017;9:67−76.

60. Tauste A, Ronda E, Molina MJ, Seguí M. Effect of contact lens use on Computer Vision Syndrome. *Ophthalmic Physiol Opt.* 2016;36(2):112−119.

61. Ranasinghe P, Wathurapatha WS, Perera YS, Lamabadusuriya DA, Kulatunga S, Jayawardana N, 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.

62. 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):179−185.

63. Reddy SC, Low C, Lim Y, Low L, Mardina F, Nursaleha M. Computer vision syndrome: a study of knowledge and practices in university students. *Nep J Oph.* 2013;5(2):161−168.

64. 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.

65. Rahman ZA, Sanip S. Computer user: demographic and computer related factors that predispose user to get computer vision syndrome. *Int J Bus, Human Technol.* 2011;1(2):84−91.

66. Vargas-Rodríguez LJ, Espitia-Lozano N, de-la-Peña-Triana HM, Vargas-Vargas JL, Mogollón-Botía DM, Pobre-Vinasco AM, et al. English Edition *Computer Visual Syndrome in University Students in Times of Pandemic*. 98. Archivos de la Sociedad Española de Oftalmología; 2023:72−77.

67. Sharma N, Singh D, Agarwal R. Assessment of prevalence and severity of digital eye strain amongst children using online learning during Covid-19. *Eur J Mol Clin Med.* 2023;10(1):3063−3071.

68. Meneses-Claudio B, Mantarí-Escobar K, Rios-Rios W, Huamani EL, Yauri-Machaca M. Computer vision syndrome in teachers of a university of the province of Lima. *Int J Adv Appl Sci.* 2023;10(1):1−6.

69. Merhy G, Akel M, Kheir N, Hallit S, Obeid S. Computer vision syndrome in lebanese male adolescents: correlates with mental health and mediating effect of stress. *Prim Care Companion CNS Disord.* 2023;25(1):45139.

70. Qolami M, Mirzajani A, Ronda-Pérez E, Cantó-Sancho N, Seguí-Crespo M. Translation, cross-cultural adaptation and validation of the Computer Vision Syndrome Questionnaire into Persian (CVS-Q FA©). *Int Ophthalmol.* 2022;42(11):3407−3420.

71. Abuallut I, Ajeebi RE, Bahari AY, Abudeyah MA, Alyamani AA, Zurayyir AJ, et al. Prevalence of computer vision syndrome among school-age children during the COVID-19 pandemic, saudi arabia: a cross-sectional survey. *Children (Basel).* 2022;9 (11):1718.

72. Shah M, Saboor A. Computer vision syndrome: prevalence and associated risk factors among computer-using bank workers in Pakistan. *Turk J Ophthalmol.* 2022;52(5):295−301.

73. Wadhwani M, Manika M, Jajoo M, Upadhyay AD. Online survey to assess computer vision syndrome in children due to excessive screen exposure during the COVID 19 pandemic lockdown. *J Family Med Prim Care.* 2022;11(9):5387.

74. Munsamy AJ, Naidoo S, Akoo T, Jumna S, Nair P, Zuma S, et al. A case study of digital eye strain in a university student population during the 2020 COVID-19 lockdown in South Africa: evidence of an emerging public health issue. *J Public Health Afr.* 2022;13(3):1−12.

75. Almousa AN, Aldofyan MZ, Kokandi BA, Alsubki HE, Alqahtani RS, Gikandi P, et al. The impact of the COVID-19 pandemic on the prevalence of computer vision syndrome among medical students in Riyadh, Saudi Arabia. *Int Ophthalmol.* 2022:1−9.

76. Artime-Ríos E, Suárez-Sánchez A, Sánchez-Lasheras F, Seguí-Crespo M. Computer vision syndrome in healthcare workers using video display terminals: an exploration of the risk factors. *J Adv Nurs.* 2022;78(7):2095−2110.

77. Seresirikachorn K, Thiamthat W, Sriyuttagrai W, Soonthornworasiri N, Singhanetr P, Yudtanahiran N, et al. Effects of digital devices and online learning on computer vision syndrome in students during the COVID-19 era: an online questionnaire study. *BMJ Paediatr Open.* 2022;6(1): e001429.

78. Aldukhayel A, Baqar SM, Almeathem FK, Alsultan FS, AlHarbi GA. Digital eye strain caused by online education among children in Qassim Region, Saudi Arabia: a cross-sectional study. *Cureus.* 2022;14(4):e23813.

79. Cantó-Sancho N, Ronda E, Cabrero-García J, Casati S, Carta A, Porru S, et al. Rasch-validated Italian scale for diagnosing digital eye strain: the computer vision syndrome questionnaire IT©. *Int J Environ Res Public Health.* 2022;19(8):4506.

80. Wangsan K, Upaphong P, Assavanopakun P, Sapbamrer R, Sirikul W, Kitro A, et al. Self-reported computer vision syndrome among Thai university students in virtual classrooms during the COVID-19 pandemic: prevalence and associated factors. *Int J Environ Res Public Health.* 2022;19(7):3996.

81. Demirayak B, Yılmaz Tugan B, Toprak M, Çinik R. Digital eye strain and its associated factors in children during the COVID-19 pandemic. *Indian J Ophthalmol.* 2022;70(3):988−992.

82. Basnet A, Pathak SB, Marasini A, Pandit R, Pradhan A. Digital eye strain among adults presenting to tertiary care hospital in the era of COVID-19 pandemic: a descriptive cross-sectional study. *JNMA J Nepal Med Assoc.* 2022;60(245):22−25.

83. Das A, Shah S, Adhikari TB, Paudel BS, Sah SK, Das RK, et al. Computer vision syndrome, musculoskeletal, and stress-related problems among visual display terminal users in Nepal. *PLoS ONE.* 2022;17(7): e0268356.

84. Coronel-Ocampos J, Gómez J, Gómez A, Quiroga-Castañeda PP, Valladares-Garrido MJ. Computer visual syndrome in medical students from a private university in paraguay: a survey study. *Front Public Health.* 2022;10: 935405.

85. Hailu Tesfaye A, Alemayehu M, Abere G, Mekonnen TH. Prevalence and associated factors of computer vision syndrome among academic staff in the university of gondar, Northwest Ethiopia: an institution-based cross-sectional study. *Environ Health Insights.* 2022;16: 11786302221111864.

86. Girum Gebresellassie M, Sisay H, Getahun B, Abera E, Birhanu H, Ashenafi T. Prevalence of computer vision syndrom and predisposing factors among engineering students in Hawass University institution of techenology campus, Hawassa, Ethiopia, 2019. *Open Ophthalmol J.* 2022;16(1).

87. Younis A, Alsabbagh L, Alaraifi D, Alsanad G, Algrain A, AlDihan R, et al. The prevalence and associated factors of self-reported symptoms of computer vision syndrome among high

school teachers in Riyadh: a cross-sectional study. *J Nat Sci Med*. 2022;5(3):292−298.

88. Imran M, Ahmad MS, Shaik RA, Alosaimi A, Almaymuni K, Albaradie N, et al. Digital Eye Strain among undergraduate medical students at Majmaah University, Saudi Arabia: CROSS-SECTIONAL STUDY. *Eur J Mol Clin Med*. 2022;9(7):651−662.

89. Uwimana A, Ma C, Ma X. Concurrent rising of dry eye and eye strain symptoms among university students during the COVID-19 pandemic era: a cross-sectional study. *Risk Manag Healthc Policy*. 2022;15:2311−2322.

90. Lotfy NM, Shafik HM, Nassief M. Risk factor assessment of digital eye strain during the COVID-19 pandemic: a cross-sectional survey. *Med Hypothesis Discov Innov Ophthalmol*. 2022;11 (3):119−128.

91. Uba-Obiano CU, Onyiaorah AA, Nwosu SNN, Okpala NE. Self-reported computer vision syndrome among bank workers in Onitsha, Nigeria. *J West Afr Coll Surg*. 2022;12(3):71−78.

92. Roy S, Sharif AB, Chowdhury S, Iktidar MA. Unavoidable online education due to COVID-19 and its association to computer vision syndrome: a cross-sectional survey. *BMJ Open Ophth*. 2022;7(1): e001118.

93. Lindo-Cano EF, García-Monge VA, Castillo-Cadillo KJ, Sánchez-Tirado EA, Távara IM, Morales J. Computer-digital Vision Syndrome Among University Students of Lima City. *Open Public Health J*. 2022;15(1): e187494452208104.

94. Fatima T, Amjad F, Hashim A, Matloob M. Frequency of computer vision syndrome among software professionals in Lahore, Pakistan. *Rawal Medical J*. 2022;47(1):221−223.

95. Estrada-Araoz EG, Parichahua-Peralta JN, Zuloaga-Araoz MC, Gallegos-Ramos NA, Paredes-Valverde Y, Quispe-Herrera R, et al. Prevalencia del síndrome visual informático en estudiantes universitarios peruanos durante la emergencia sanitaria por COVID-19. *Arch Venez de Farmacol y Ter*. 2022;41 (4):264−270.

96. Panda TK, Soni S, Nanda P. Digital eye strain and dry eye problemsin Covid-19 lockdown, at BBMCH, Balangir. *NeuroQuantology.*. 2022;20(10):6704−6711.

97. AlDarrab A, Khojah AA, Al-Ghazwi MH, Al-Haqbani YJ, Al-Qahtani NM, MN Al-Ajmi, et al. Magnitude and determinants of computer vision syndrome among college students at a Saudi University. *Middle East Afr J Ophthalmol*. 2022;28(4):252.

98. Gerena-Pallares LC, Rodríguez LJV, Avendaño CAN, Uyaban GC, Virgen YB. Prevalencia del síndrome visual por computadora en los estudiantes de medicina de la ciudad de Tunja durante la pandemia. *Rev Colomb Salud Ocup*. 2022;12(1):e−7916.

99. Simon C, Paul S. Prevalence and determinants of digital eye strain among school children during the COVID-19 pandemic. *Int J Community Med Public Health*. 2022;9(1):7−15.

100. Dávila-Morán RC, Agüero-Corzo EDC, Portillo-Rios H, Velarde-Dávila L, Ruiz-Nizama JL. Lucha epidemiológica contra pandemia COVID-19: impacto de las medidas sociales en el SVI. *Bol Malariol y Sal Amb*. 2021;61(4):683−692.

101. Alqarni TM, Hakami AAH, Dibaji MQ. Computer vision syndrome among undergraduate medical students in Jazan University, Saudi Arabia. *Korean J Intern Med*. 2021;36(4):1−21.

102. Setyowati DL, Nuryanto MK, Sultan M, Sofia L, Gunawan S, Wiranto A. Computer vision syndrome among academic community in Mulawarman University, Indonesia during work from home in COVID-19 pandemic. *Ann Trop Med Public Health*. 2021;24(01).

103. Gutiérrez SCH, Tuesta JM, Rojas CEO, Cruz DR, Muñoz ST. Síndrome Visual Informático y estrés académico en estudiantes de enfermería durante el confinamiento por la COVID-19. *Revista de la Universidad del Zulia*. 2021;12(35):572−583.

104. Qolami M, Cantó-Sancho N, Seguí-Crespo M, Ronda-Pérez E, Mirzajani A, Taghizade G. Prevalence of computer vision syndrome among Iranian medical university employees and

105. graduate students in their occupational environment. *Func. Disabil J.*. 2021;15(3):151−160.

106. Gautam PS, Prakash UC, Dangol S. Study on knowledge and prevalence of computer vision syndrome among computer operators in nobel medical college teaching Hospital, Biratnagar, Nepal. *J Nobel Med Coll*. 2020;9(2):45−49.

107. Rafeeq U, Omear M, Chauhan L, Maan V, Agarwal P. Computer vision syndrome among individuals using visual display terminals for more than two hours. *Delta J Ophthalmol*. 2020;21:139−145.

108. Ranganatha S, Jailkhani S. 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 Int J Health Sci Res*. 2019;4(3):10−15.

109. Pulla A, Asma Samyuktha N, Kasubagula S, Kataih A, Banoth D, et al. A cross sectional study to assess the prevalence and associated factors of computer vision syndrome among engineering students of Hyderabad, Telangana. *Int J Commun Med Public Health*. 2019;6(1):308−313.

110. Tesfa M, Mohammed IS, Yohannes M, Ashete AG, Leyla TA. Computer vision syndrome and its predictors among secretary employees working in Jimma University, Southwest Ethiopia. *J Environ Occup Health*. 2021;11(2):27−36.

111. Agbonlahor O. Prevalence and knowledge of Computer Vision Syndrome (CVS) among the working class adults in F.C.T. Nigeria. *J Niger Optom Assoc*. 2019;21(1):49−60.

112. Subaie MA, Al-Dossari S, Bougmiza MI. Computer vision syndrome among mobile phone users in Al-Ahsa, Kingdom of Saudi Arabia. *Albasar Int J Ophthalmol*. 2017;4(4):99−103.

113. Rathore MK, Kangale V, Kulkarni CV, Rawat P, Walia S. A cross sectional study to assess prevalence of computer vision syndrome and vision related problems in computer users. *J Med Sci Clin Res*. 2016;4(6):11007−11012.

114. 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 Journal of Ophthalmology*. 2016;32(3):140−146.

115. Hassan J, Ehsan S. Frequency of computer vision syndrome & ergonomic practices among computer engineering students. *Int J Sci Res (IJSR)*. 2016;5(5):121−125.

116. Zainuddin H, Isa MM. Effect of human and technology interaction: computer vision syndrome among administrative staff in a public university. *Int J Bus, Human Technol*. 2014;4(3):39−44.

117. Arumugam S, Kumar K, Subramani R, Kumar S. Prevalence of computer vision syndrome among information technology professionals working in Chennai. *World J Med Sci*. 2014;11 (3):312−314.

118. Hassan A, kashif M. Prevalence of computer vision syndrome (CVS) amongst the students of Khyber Medical University, Peshawar. *Ophthalmol Update*. 2017;15(2):59−64.

119. Iqbal M, El-Massry A, Elagouz M, Elzembely H. Computer vision syndrome survey among the medical students in Sohag University Hospital, Egypt. *Ophthalmol Res*. 2018;8(1):1−8.

120. Adane F, Alamneh YM, Desta M. Computer vision syndrome and predictors among computer users in Ethiopia: a systematic review and meta-analysis. *Trop Med Health*. 2022;50(1):26.

121. Loh K, Redd S. Understanding and preventing computer vision syndrome. *Malays Fam Physician*. 2008;3(3):128−130.

122. Blehm C, Vishnu S, Khattak A, Mitra S, Yee RW. Computer vision syndrome: a review. *Surv Ophthalmol*. 2005;50(3):253−262.

123. Singh S, McGuinness MB, Anderson AJ, Downie LE. Interventions for the management of computer vision syndrome: a systematic review and meta-analysis. *Ophthalmology*. 2022;129 (10):1192−1215.

124. González-Pérez M, Susi R, Antona B, Barrio A, González E. The computer-vision symptom scale (CVSS17): development and

initial validation. *Invest Ophthalmol Vis Sci*. 2014;55 (7):4504−4511.

124. Rossi GCM, Bettio F, González-Pérez M, Briola A, Pasinetti GLM, Scudeller L. The 17-item computer vision symptom scale questionnaire (CVSS17): translation, validation and reliability of the Italian version. *Int J Environ Res Public Health*. 2022;19 (5):2517.

125. Courtin R, Pereira B, Naughton G, Chamoux A, Chiambaretta F, Lanhers C, et al. Prevalence of dry eye disease in visual display terminal workers: a systematic review and meta-analysis. *BMJ Open*. 2016;6(1): e009675.

126. Parihar JKS, Jain VK, Chaturvedi P, Kaushik J, Jain G, Parihar AKS. Computer and visual display terminals (VDT) vision syndrome (CVDTS). *Med J Armed Forces India*. 2016;72(3):270−276.

127. Mowatt L, Gordon C, Santosh ABR, Jones T. Computer vision syndrome and ergonomic practices among undergraduate university students. *Int J Clin Pract*. 2018;72(1):e13035.

128. Bubric K, Hedge A. Differential patterns of laptop use and associated musculoskeletal discomfort in male and female college students. *Work*. 2016;55(3):663−671.

129. Castro O, Bennie J, Vergeer I, Bosselut G, Biddle SJH. How sedentary are university students? A systematic review and meta-analysis. *Prev Sci*. 2020;21(3):332−343.

130. Talic S, Shah S, Wild H, Gasevic D, Maharaj A, Ademi Z, et al. Effectiveness of public health measures in reducing the incidence of covid-19, SARS-CoV-2 transmission, and covid-19 mortality: systematic review and meta-analysis. *BMJ*. 2021; 375:e068302.

131. Bahkir FA, Grandee SS. Impact of the COVID-19 lockdown on digital device-related ocular health. *Indian J Ophthalmol*. 2020;68(11):2378−2383.

132. Beckel JLO, Fisher GG. Telework and worker health and well-being: a review and recommendations for research and practice. *Int J Environ Res Public Health*. 2022;19(7):3879.