Check for updates

Received: 19 April 2021 | Revised: 18 October 2021 | Accepted: 9 December 2021
DOI: 10.1111/jan.15140

JAN Leading Global Nursing Research WILEY

ORIGINAL RESEARCH:
EMPIRICAL RESEARCH – QUANTITATIVE

Computer vision syndrome in healthcare workers using video display terminals: an exploration of the risk factors

Eva Artime-Ríos[1,2] | Ana Suárez-Sánchez[3] | Fernando Sánchez-Lasheras[4] | Mar Seguí-Crespo[5,6]

[1]Occupational Health Service, Healthcare Area IV, Public Health Service of the Principality of Asturias (SESPA), Oviedo, Spain

[2]Doctoral Programme in Health Sciences, University of Alicante, Alicante, Spain

[3]Department of Business Administration, University of Oviedo, Oviedo, Spain

[4]Department of Mathematics, University of Oviedo, Oviedo, Spain

[5]Department of Optics, Pharmacology and Anatomy, University of Alicante, Alicante, Spain

[6]Public Health Research Group, University of Alicante, Alicante, Spain

Correspondence
Eva Artime-Ríos, Occupational Health Nurse, Occupational Health Service, Healthcare Area IV, Monte Naranco Hospital, Public Health Service of the Principality of Asturias (SESPA), Avda. Dres. Fernández-Vega, 9, 33012, Oviedo, Spain.
Email: evam.artime@sespa.es

Funding information
This work was supported by the PREVENT Foundation, Spain, XIV Research and Development Grants in Occupational Health and Safety, 2020.

Abstract

Aims: To estimate the prevalence of computer vision syndrome (CVS) in healthcare workers and its relationship to video display terminal (VDT) exposure, sociodemographic, optical correction and work characteristics, and to analyse whether there are differences among occupational groups.

Design: Cross-sectional study.

Methods: A sample of 1179 physicians and surgeons, nurses, and nursing assistants from two hospitals in Spain between January 2017 and February 2018 were invited to participate in this study. Of these, 622 workers from both hospitals were finally included. CVS was measured using a questionnaire, the CVS-Q©. Logistic regression was used to identify the factors associated with CVS. All the results were stratified by occupational group.

Results: The prevalence of CVS was 56.75% with nurses being the most affected occupational group (61.75%). It was associated significantly with female sex (aOR = 2.57; 95% CI 1.36–4.88) and morning shifts plus on-call (aOR = 2.33; 95% CI 1.11–4.88) in the physicians and surgeons group. Among the nurses, it was associated with female sex (aOR = 2.35; 95% CI 1.03–5.37), seniority between 10 and 20 years (aOR = 2.17; 95% CI 1.03–4.59), VDT exposure at work of 2–4 h/day (aOR = 6.14; 95% CI 1.08–35.02), VDT exposure at work >4 h/day (aOR = 7.14; 95% CI 1.29–39.62) and self-perception that using the software application was not easy (aOR = 2.49; 95% CI 1.23–5.01).

Conclusions: A high prevalence of CVS among healthcare workers was observed. The risk factors that increased the likelihood of suffering from this syndrome depended on the occupation.

Impact: The findings may be used as a reference for occupational health services to implement specific preventive measures to reduce CVS for each occupational group. Such measures should consider both individual factors and the working conditions.

KEYWORDS
computer terminals, computer vision syndrome, health personnel, nurses, nursing assistants, occupational exposure, occupational health, physicians, surgeons, video display terminals

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.
© 2022 The Authors. *Journal of Advanced Nursing* published by John Wiley & Sons Ltd.

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

1 | INTRODUCTION

According to the Sixth European Working Conditions Survey (Eurofound, 2017), more than half of European workers used video display terminals (VDTs) at work with financial services, public administration, education, and health being the economic sectors with the most widespread use of VDTs. In Spain, the implementation of the use of electronic health records (EHRs) in the National Health System, supported by Act 16/2003 (BOE 128, 29 May, 2003) and by Act 41/2002 (BOE 274, 15 Nov, 2002), has resulted in a significant change in the manner in which the different healthcare professionals, work. With most of these health professionals (more than 90%) spending 2 or more hours using a VDT at work (Artime Ríos et al., 2019, 2020), they have been considered to be VDT users according to the Royal Decree 488/1997 (BOE 97, 23 Apr., 1997).

1.1 | Background

The prolonged use of computers at work by healthcare workers has also been observed in other countries. Hyon et al. (2019) reported an average exposure to a VDT at work of 7.4 h/day (*SD* 2.5) in paramedical workers. Some healthcare workers work frequently in a standing position at the bedside of a patient. Thus, since not all jobs are designed for sedentary work, healthcare workers using VDTs in the healthcare sector may experience some difficulties. This is the case for nurses who use these terminals for the administration of medication or portable terminals used during medical visits. This new way of working has entailed changes, both in the work tasks and in the interactions between healthcare professionals, which increases stress and has a negative impact on their health (Morrison & Lindberg, 2008). In line with the spread of teleworking or online working, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic has increased the use of VDTs in the health sector substantially. Worldwide, online consultations by telephone or video have been promoted to avoid face-to-face contact in primary care.

The use of VDTs for long periods of time has been related to intense accommodative efforts, a decreased blink rate, and increased tear film evaporation, which can compromise the condition of the ocular surface and the binocular vision status, resulting in discomfort (Jaiswal et al., 2019). The American Optometric Association (AOA, 2020) defined the computer vision syndrome (CVS) as a group of eye- and vision-related problems that result from prolonged computer, tablet, e-reader, and cell phone use. The CVS has been studied extensively over the past decade, although other terms, such as asthenopia, visual fatigue, or eyestrain, have also been used to refer to the same construct. The prevalence of the CVS varies considerably from one study to another, with figures ranging between 20% (Ye et al., 2007) and 80% (Fenga et al., 2008). Such differences can be explained by methodological variations between studies, mainly due to different definitions of "case" and the lack of validated instruments for diagnosis. Nevertheless, Seguí et al. (2015) designed and validated a Spanish questionnaire to estimate the prevalence of the CVS.

The CVS has a multifactorial aetiology. Several authors have pointed out that the probability of workers suffering from CVS increases with the daily time of exposure to VDTs (Dessie et al., 2018; Rahman & Sanip, 2011). While the lack of breaks taken, and the years of use, can be work-related risk factors (Assefa et al., 2017; Larese Filon et al., 2019), there are also risk factors inherent in the worker, including female sex (Sa et al., 2012), advanced age (Rossi et al., 2019), previous eye diseases (Ranasinghe et al., 2016), previous refractive surgeries (Aakre & Doughty, 2007), the use of some systemic treatments (Castro et al., 2018) and the use of contact lenses (Tauste et al., 2016), that can also aggravate this symptomatology.

The majority of the CVS studies have analysed occupations linked mainly to office work (Assefa et al., 2017; Dessie et al., 2018; Sánchez-Brau et al., 2020). Very few published studies have analysed the effects of exposure to VDTs on the visual health of healthcare workers. A study carried out in North America with a sample of 380 radiologists who used computer screens as a viewing method at work estimated a prevalence of eye strain of 36% (Vertinsky & Forster, 2005). Other studies conducted in hospitals either focused on a sample of janitors and computer operators (Yazici et al., 2015), or did not specify whether their sample consisted of healthcare workers (Jackson et al., 1997; Ünlü et al., 2012). However, a literature review (Klamm & Tarnow, 2015) concluded that the occurrence of the CVS should be considered in nurses and other healthcare professionals because of the use of tablets and laptops in hospitals. More recently, two studies (Artime Ríos et al., 2019, 2020) that administered the questionnaire by Seguí et al. (2015) to their respondents, used artificial intelligence techniques to predict the scores achieved and the characteristics of the healthcare workers with this syndrome. However, the samples of both studies were insufficient to measure prevalence consistently. Likewise, although from a different perspective, the recent publication of a clinical case (Lurati, 2018) emphasized the implications of the CVS in occupational nursing, recommending annual visual examinations of workers aged over 40 years, as well as the administration of questionnaires for the assessment of dry eye symptoms.

Thus, the effects of an increase in the exposure to VDTs in their work, due to the implementation of EHRs in the National Health System, on the visual health of health workers should be assessed, using a validated tool to evaluate the CVS (Seguí et al., 2015), and in so doing correct the methodological limitations of previous studies.

Considering the inherent differences in the tasks performed by physicians, nurses, and nursing assistants when using VDTs at work, it will be important to analyse each occupational group separately. Soria-Oliver et al. (2019) found differences in the levels of visual discomfort between the different patterns of VDT use, and Jaschinski et al. (2015) found that the reported extent of headache, ocular, and musculoskeletal strain among those who performed more demanding occupational tasks increased with the daily duration of computer work.

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

2 | THE STUDY

2.1 | Aims

The aim of this study was to estimate the prevalence of the CVS in a sample of healthcare workers and the relationship of this syndrome to VDT exposure, optical correction and sociodemographic and work characteristics, and to analyse whether there were differences in the syndrome according to different occupational groups.

2.2 | Design

This was a cross-sectional study based on the Strengthening the Reporting for Observational Studies in Epidemiology guidelines (von Elm et al., 2008).

2.3 | Participants

The study was conducted in two hospitals in Oviedo, Spain: Monte Naranco Hospital (HMN) and Central University Hospital of Asturias (HUCA). The first, specializing in geriatrics and palliative care, implemented the EHR in 2007. The second, a reference hospital for the network of hospitals in the area and implemented the EHR in 2014.

The study population included healthcare professionals from the following occupational groups: physicians and surgeons (including residents), nurses (including nurse specialists), and nursing assistants. Participants were excluded if (1) they belonged to a different occupational group (physiotherapists, speech therapists, pharmacists, biologists, physicists, among others); (2) they were students; (3) they did not use VDTs in their jobs; (4) they had been working for less than 1 year in their jobs; (5) they were on maternity leave or had prolonged temporary disabilities; (6) they were full-time union representatives; (7) they were retired; (8) their employment was terminated; (9) they were suffering from diagnosed eye diseases and/or were undergoing ocular treatment at the time of the study; and/or (10) had undergone refractive surgeries.

For the selection of the sample, we considered the differences in the target populations of both hospitals: 279 workers from HMN and 3909 from HUCA. In HMN, we included all of the healthcare workers as the target population, to take into account the possibility of the high percentage of losses that could affect the representativeness of the sample. In HUCA, stratified random sampling was carried out using the lists of active personnel of the occupational groups included in the study. The total population was divided into the following strata: physicians and surgeons (1068 workers), nurses (1622 workers), and nursing assistants (1219 workers). The sample was selected randomly from a number proportional to the components of each stratum. Assuming a CVS prevalence of 20% (Ye et al., 2007), a 95% confidence level and a precision of 5%, the estimated sample sizes in the second hospital were 201 physicians and surgeons, 214 nurses, and 205 nursing assistants. Therefore, taking into account a possible loss of approximately 40%–45%, 290 physicians and surgeons, 311 nurses, and 299 nursing assistants were invited to participate in the study. Finally, out of a total of 1179 healthcare professionals from both hospitals who were contacted, a sample of 622 was included in the study (139 from HMN and 483 from HUCA), as shown in Figure 1.

2.4 | Data collection

Between January 2017 and February 2018, a research team member contacted the selected participants directly at their work units. Each subject was given an envelope containing the following documents: (1) an instruction sheet; (2) an informed consent document; (3) an ad hoc questionnaire with regard to anamnesis, occupational information, and history of exposure to VTD; and (4) a CVS questionnaire (CVS-Q©). The workers were able to obtain clarifications about the study on-site, and those who decided to participate signed the informed consent document, which was collected at the same time. The ad hoc and CVS-Q questionnaires were delivered to the participants with personal identification numbers to guarantee their anonymity of the participants. Since both of the questionnaires were self-administered, deadlines and collection methods were agreed with each worker.

The questionnaire on anamnesis, occupational information, and history of exposure to VTD was developed to collect information about the sociodemographic variables (sex and age), ocular history (ophthalmic or contact lens use, previous eye diseases, ocular treatment, and/or ocular surgeries), job characteristics (hospital, occupational groups, work schedules, and seniority), history of exposure to VDTs at work (hours per day of use), opinions about the ease of use of the software applications, and exposure to VDTs outside of work. Age was categorized as ≤35, 36–45, and >45 years, since each of these groups have different accommodative conditions (Girum et al., 2017; Rozanova et al., 2018). Seniority was categorized as ≤10, 10–20, and >20 years because these cut-off points divided the sample into three groups of similar sizes. Exposure to VDTs at work was categorized as <2, 2–4, and >4 h/day according to the definition of VDT workers in the implementation of the Royal Decree 488/1997 (BOE 97, 23 Apr., 1997).

The CVS-Q© (Seguí et al., 2015) was used to measure the ocular and visual symptoms perceived by the worker throughout the time of computer use at work or immediately after working hours. This questionnaire assessed the frequency (never, occasionally, or often/always) and the intensity (moderate or intense) of 16 symptoms: burning, itching, feeling of a foreign body, tearing, excessive blinking, eye redness, eye pain, heavy eyelids, dryness, blurred vision, double vision, difficulty focusing for near vision, increased sensitivity to light, coloured halos around objects, feeling that sight is worsening, and headache. Once completed by the worker, the researcher calculated and recoded the severity of each symptom and established a total score after adding the severity. If the total score was greater than or equal to six, the worker was considered to be suffering from the CVS.

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

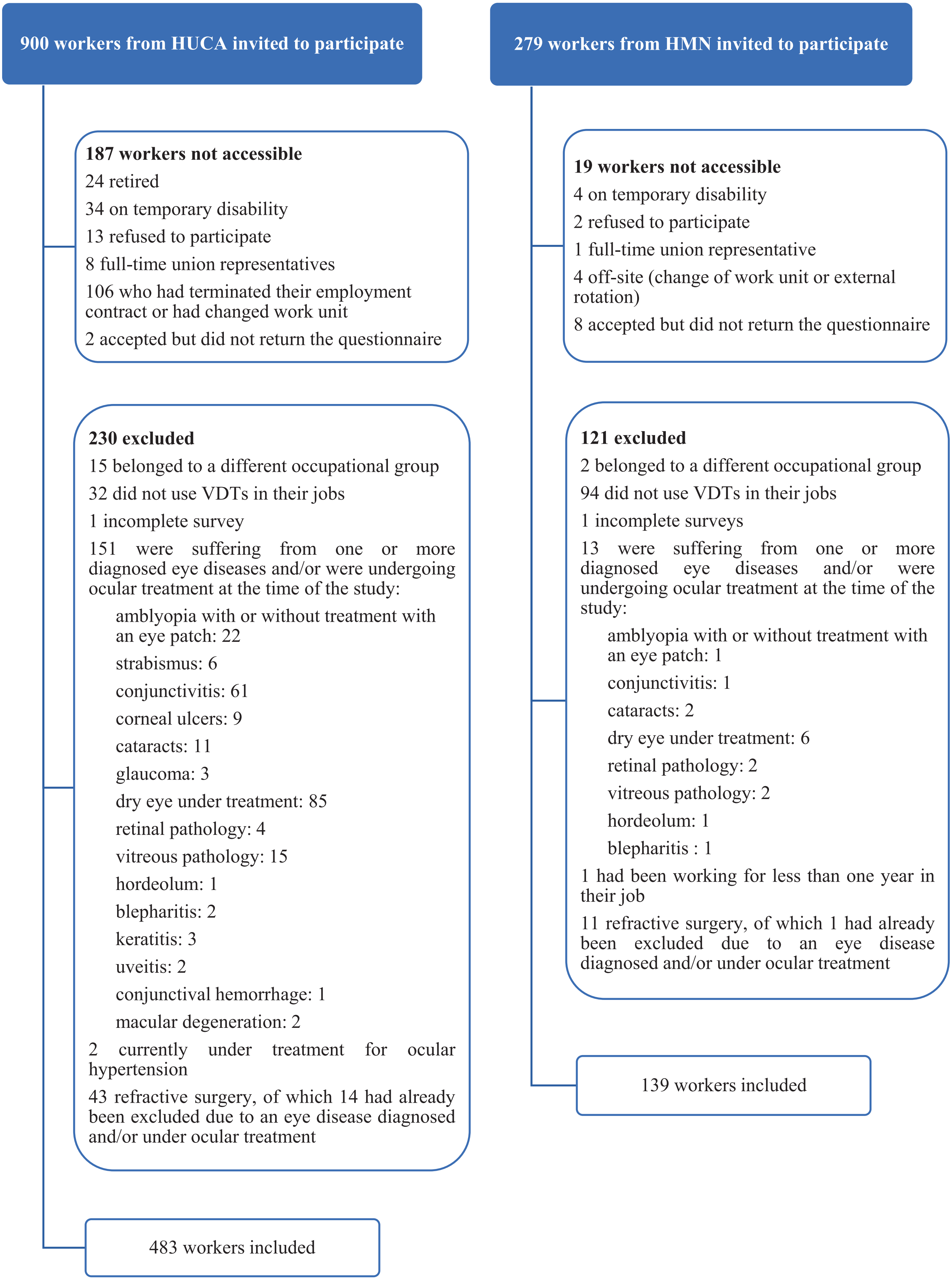

FIGURE 1 Flow of participants through the study, including reasons for exclusion/not accessibility

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

2.5 | Ethical considerations

This study was approved by the Research Ethics Committee of the university (no. UA-2016-07-13) and hospitals (no. 148/16). The study was conducted in accordance with the tenets of the Declaration of Helsinki, the International Conference on Harmonisation Good Clinical Practice Guidelines and the Organic Act 3/2018 on Personal Data Protection (BOE 294, 6 Dec., 2018). All the participants provided written informed consent.

2.6 | Data analysis

A descriptive analysis was performed, including measures of central tendency for the continuous variables, and absolute and relative frequencies for the categorical variables. The dependent variable was the presence of the CVS, which was calculated according to the CVS-Q© score. The total prevalence of the CVS and the prevalence in each group were calculated according to the different explanatory variables. To assess the existence of significant differences in the prevalence observed in the different groups, the chi-square test was used (or Fisher's exact test in frequencies lower than or equal to five for some of the categories considered). The magnitudes of the bivariate associations of the prevalence of the CVS in the different categories of the explanatory variables were calculated using crude odds ratios and their confidence intervals at 95% (95% CI) that were estimated with binary logistic regression models. To identify the factors associated with a CVS, a multivariate logistic model was used to estimate the adjusted odds ratios (ORa) and their 95% CI. All the variables were considered as predictors to create a model that was as informative as possible. All the results were stratified by occupational group, and the Hosmer–Lemeshow test, the area under the curve (AUC), and the Omnibus test were used to evaluate the fit of the models. Statistical significance was set at $p < .05$. IBM SPSS Statistics version 24 was used for statistical analysis.

2.7 | Validity and reliability

The data were collected using the CVS-Q©, a validated instrument (Seguí et al., 2015). According to the Rasch analysis, this questionnaire has acceptable psychometric properties with sensitivity and specificity values of 75.0% and 70.2%, respectively, making it a valid and reliable tool to perform quality studies on workers exposed to VDTs in Spain, and particularly on those occupational groups that are more vulnerable to visual discomfort.

3 | RESULTS

3.1 | Characteristics of the study population

As shown in Table 1, the mean age of the sample was 46.34 years (*SD* 10.97). While there were more women than men in the entire sample (79.10%), this was especially so in the occupational groups of nurses (88.77%) and nursing assistants (96.97%). Of the sample, 72.99% wore ophthalmic lenses and 16.08% contact lenses. The mean seniority of the workers was 18.11 years (*SD* 11.27). With regard to work schedules, 61.95% of the physicians and surgeons performed morning shifts plus on-call, and 55.09% of the nurses and 74.24% of the nursing assistants performed rotating shifts including nights. The average duration of VDT use at work was 4.89 h/day (*SD* 2.53) and 55.95% of the participants used VDTs for more than 4 h a day. The group most exposed to VDTs at work were physicians and surgeons (mean = 6.17, *SD* 2.32 h/day), especially those who worked in the emergency room, reanimation, and intensive care medicine. These were followed by nurses (mean = 4.97, *SD* 2.08 h/day) and nursing assistants (mean = 2.72, *SD* 2.31 h/day). The majority of the individuals (75.08%) considered that the software application was easy to use.

3.2 | Prevalence of the CVS

The total prevalence of the CVS was 56.75%, and no significant differences in prevalence were observed between hospitals. The prevalence of the CVS was significantly higher in women (60.77%), ophthalmic lens wearers (59.69%), and contact lens wearers (69.00%). Significant differences were also observed according to seniority ($p = .004$) and computer use outside of work ($p = .044$); workers with 10–20 years of seniority and those who used a computer outside of work presented with a higher prevalence (66.32% and 58.63%, respectively; Table 2).

Nurses had a higher prevalence of the CVS (61.75%) than physicians and surgeons (51.71%) and nursing assistants (53.79%), but these differences were not significant. Among the physicians, there were significant differences in prevalence by sex ($p = .001$), use of ophthalmic lenses ($p = .024$), use of contact lenses ($p = .010$), and work schedule ($p = .032$). Among the nurses, significant differences in prevalence were observed according to seniority ($p = .019$), hours of use of VDT at work ($p = .015$), and perceived user-unfriendliness of the software application ($p = .013$). Finally, among the nursing assistants, these differences were observed only according to the number of hours of computer use outside of work ($p = .036$; Table 2).

Significant prevalence differences were found between the occupational groups in non-contact lens wearers ($p = .040$) and in the participants with greater difficulties in using the software applications ($p = .008$). In both cases, the nurses had the highest prevalence of the CVS (Table 2).

3.3 | Factors associated with the CVS

The results of the bivariate analysis (Table 3) showed that, in the entire sample of health personnel, female sex, the use of ophthalmic or contact lenses, a 10–20 years seniority, shift work including

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 Demographic, individual and work characteristics of the studied sample

Variables	Total sample (*n* = 622)	Physicians and surgeons (*n* = 205)	Nurses and nurse specialists (*n* = 285)	Nursing assistants (*n* = 132)
Sex, *n* (%)				
Male	130 (20.90%)	94 (45.85%)	32 (11.23%)	4 (3.03%)
Female	492 (79.10%)	111 (54.15%)	253 (88.77%)	128 (96.97%)
Age (years), *n* (%)				
≤35	126 (20.26%)	48 (23.41%)	67 (23.51%)	11 (8.33%)
36 to ≤45	145 (23.31%)	48 (23.41%)	80 (28.07%)	17 (12.88%)
>45	351 (56.43%)	109 (53.17%)	138 (48.42%)	104 (78.79%)
Mean (*SD*)	46.34 (10.97)	45.13 (11.60)	44.76 (10.62)	51.64 (8.95)
Median (range)	49 (22–67)	47 (25–67)	45 (22–64)	54 (26–64)
Ophthalmic lens wearers, *n* (%)				
No	168 (27.01%)	48 (23.41%)	93 (32.63%)	27 (20.45%)
Yes	454 (72.99%)	157 (76.59%)	192 (67.37%)	105 (79.55%)
Contact lens wearers, *n* (%)				
No	522 (83.92%)	158 (77.07%)	241 (84.56%)	123 (93.18%)
Yes	100 (16.08%)	47 (22.93%)	44 (15.44%)	9 (6.82%)
Hospital, *n* (%)				
HUCA	483 (77.65%)	163 (79.51%)	197 (69.12%)	123 (93.18%)
HMN	139 (22.35%)	42 (20.49%)	88 (30.88%)	9 (6.82%)
Seniority (years), *n* (%)				
≤10	194 (31.19%)	72 (35.12%)	85 (29.82%)	37 (28.03%)
>10 to ≤20	190 (30.55%)	54 (26.34%)	85 (29.82%)	51 (38.64%)
>20	238 (38.26%)	79 (38.54%)	115 (40.35%)	44 (33.33%)
Mean (*SD*)	18.11 (11.27)	17.60 (11.72)	18.30 (10.86)	18.48 (11.50)
Median (range)	16 (1–46)	17 (1–45)	16 (1–42)	16 (1–46)
Work schedule, *n* (%)				
Day shifts only	215 (34.57%)	69 (33.66%)	112 (39.30%)	34 (25.76%)
Rotating shifts including nights	264 (42.44%)	9 (4.39%)	157 (55.09%)	98 (74.24%)
Morning shifts plus on-call	143 (22.99%)	127 (61.95%)	16 (5.61%)	–
Use of VDT at work (h/day), *n* (%)				
<2	71 (11.41%)	–	10 (3.51%)	61 (46.21%)
2 to ≤4	203 (32.64%)	45 (21.95%)	118 (41.40%)	40 (30.30%)
>4	348 (55.95%)	160 (78.05%)	157 (55.09%)	31 (23.48%)
Mean (*SD*)	4.89 (2.53)	6.17 (2.32)	4.97 (2.08)	2.72 (2.31)
Median (range)	5 (0.5–18.0)	6 (2.0–18.0)	5 (1.0–10.0)	2 (0.5–8.0)
Easy software application, *n* (%)				
Yes	467 (75.08%)	132 (64.39%)	224 (78.60%)	111 (84.09%)
No	155 (24.92%)	73 (35.61%)	61 (21.40%)	21 (15.91%)
Use of computer outside work, *n* (%)				
No	112 (18.01%)	13 (6.34%)	61 (21.40%)	38 (28.79%)
Yes	510 (81.99%)	192 (93.66%)	224 (78.60%)	94 (71.21%)
Mean (*SD*)	1.52 (1.39)	2.04 (1.45)	1.29 (1.33)	1.22 (1.16)
Median (range)	1 (0–16)	2 (0–9)	1 (0–16)	1 (0–5)

Abbreviation: *SD*, standard deviation.

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 Prevalence of the CVS according to demographic, individual and work factors

Variables	Total sample		Physicians and surgeons		Nurses and nurse specialists		Nursing assistants		
	n (%)	*p*[a]	*n* (%)	*p*[a]	*n* (%)	*p*[a]	*n* (%)	*p*[a]	*p*[b]
No. of subjects	353 (56.75)		106 (51.71)		176 (61.75)		71 (53.79)		.064[c]
Sex		<.001[c]		.001[c]		.066[c]		1.000[d]	
Male	54 (41.54)		37 (39.36)		15 (46.88)		2 (50.00)		.679[d]
Female	299 (60.77)		69 (62.16)		161 (63.64)		69 (53.91)		.174[c]
Age (years)		.538[c]		.964[c]		.282[c]		1.000[d]	
≤35	69 (54.76)		25 (52.08)		38 (56.72)		6 (54.55)		.927[d]
36 to ≤45	88 (60.69)		24 (50.00)		55 (68.75)		9 (52.94)		.086[c]
>45	196 (55.84)		57 (52.29)		83 (60.14)		56 (53.85)		.415[c]
Ophthalmic lens wearers		.015[c]		.024[c]		.158[c]		.275[c]	
No	82 (48.81)		18 (37.50)		52 (55.91)		12 (44.44)		.103[c]
Yes	271 (59.69)		88 (56.05)		124 (64.58)		59 (56.19)		.191[c]
Contact lens wearers		.007[c]		.010[c]		.103[c]		1.000[d]	
No	284 (54.41)		74 (46.84)		144 (59.75)		66 (53.66)		.040[c]
Yes	69 (69.00)		32 (68.09)		32 (72.73)		5 (55.56)		.560[d]
Hospital		.982[c]		.552[c]		.928[c]		1.000[d]	
HUCA	274 (56.73)		86 (52.76)		122 (61.93)		66 (53.66)		.158[c]
HMN	79 (56.83)		20 (47.62)		54 (61.36)		5 (55.56)		.319[d]
Seniority (years)		.004[c]		.421[c]		.019[c]		.209[c]	
≤10	106 (54.64)		36 (50.00)		49 (57.65)		21 (56.76)		.606[c]
>10 to ≤20	126 (66.32)		32 (59.26)		63 (74.12)		31 (60.78)		.121[c]
>20	121 (50.84)		38 (48.10)		64 (55.65)		19 (43.18)		.311[c]
Work schedule		.053[c]		0.032[d]		.428[c]		.607[c]	
Day shifts only	108 (50.23)		27 (39.13)		64 (57.14)		17 (50.00)		.063[c]
Rotating shifts including nights	161 (60.98)		5 (55.56)		102 (64.97)		54 (55.10)		.288[d]
Morning shifts plus on-call	84 (58.74)		74 (58.27)		10 (62.50)		–		.746[c]
Use of VDT at work (h/day)		.091[c]		.444[c]		.015[d]		.615[c]	
<2	32 (45.07)		–		2 (20.00)		30 (49.18)		.102[d]
2 to ≤4	115 (56.65)		21 (46.67)		71 (60.17)		23 (57.50)		.296[c]
>4	206 (59.20)		85 (53.13)		103 (65.61)		18 (58.06)		.077[c]
Easy software application		.259[c]		.610[c]		0.013[c]		.737[c]	
Yes	259 (55.46)		70 (53.03)		130 (58.04)		59 (53.15)		.561[c]
No	94 (60.65)		36 (49.32)		46 (75.41)		12 (57.14)		.008[c]
Use of computer outside work		.044[c]		.396[d]		.275[c]		.036[c]	
No	54 (48.21)		5 (38.46)		34 (55.74)		15 (39.47)		.225[d]
Yes	299 (58.63)		101 (52.60)		142 (63.39)		56 (59.57)		.082[c]

Note: *p*-value derived from Chi-square test or Fisher's exact test in those categories with at least one of the frequencies of 5 or less.

Abbreviation: *p*, *p*-value.

[a]Differences between categories of variables.

[b]Differences between occupational groups.

[c]Chi-square test.

[d]Fisher's exact test.

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 3 Association between CVS and demographic, individual and work factors

	Total sample			Physicians and surgeons			Nurses and nurse specialists			Nursing assistants		
Variables	**cOr**	**95% CI**	***p*-value**	**cOr**	**95% CI**	***p*-value**	**cOr**	**95% CI**	***p*-value**	**cOr**	**95% CI**	***p*-value**
Sex												
Male	1.00			1.00			1.00			1.00		
Female	2.18	1.47–3.23	<.001	2.53	1.44–4.45	.001	1.98	0.95–4.16	.070	1.17	0.16–8.56	.877
Age (years)												
≤35	1.00			1.00			1.00			1.00		
36 to ≤45	1.28	0.79–2.07	.324	0.92	0.41–2.05	.838	1.68	0.85–3.30	.133	0.94	0.21–4.29	.934
>45	1.05	0.69–1.57	.834	1.01	0.51–1.99	.981	1.15	0.64–2.08	.640	0.97	0.28–3.39	.965
Ophthalmic lens wearers												
No	1.00			1.00			1.00			1.00		
Yes	1.55	1.09–2.22	.015	2.13	1.09–4.13	.026	1.44	0.87–2.38	.159	1.60	0.68–3.76	.277
Contact lens wearers												
No	1.00			1.00			1.00			1.00		
Yes	1.87	1.18–2.95	.008	2.42	1.22–4.82	.012	1.80	0.88–3.66	.107	1.08	0.28–4.21	.912
Hospital												
HUCA	1.00			1.00			1.00			1.00		
HMN	1.00	0.69–1.47	.982	0.81	0.41–1.61	.552	0.98	0.58–1.64	.928	1.08	0.28–4.21	.912
Seniority (years)												
≤10	1.00			1.00			1.00			1.00		
>10 to ≤20	1.63	1.08–2.47	.020	1.46	0.71–2.97	.303	2.10	1.10–4.02	.025	1.18	0.50–2.79	.705
>20	0.86	0.59–1.26	.432	0.93	0.49–1.76	.816	0.92	0.52–1.62	.778	0.58	0.24–1.40	.225
Work schedule												
Day shifts only	1.00			1.00			1.00			1.00		
Rotating shifts including nights	1.55	1.08–2.23	.019	1.94	0.48–7.89	.352	1.39	0.85–2.29	.194	1.23	0.56–2.68	.607
Morning shifts plus on-call	1.41	0.92–2.16	.114	2.17	1.19–3.95	.011	1.25	0.43–3.68	.685	–	–	–
Use of VDT at work (h/day)												
<2	1.00			–	–	–	1.00			1.00		
2 to ≤4	1.59	0.93–2.74	.093	1.00			6.04	1.23–29.71	.027	1.40	0.63–3.12	.414
>4	1.77	1.06–2.96	.030	1.30	0.67–2.51	.444	7.63	1.57–37.19	.012	1.43	0.60–3.42	.421
Easy software application												

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 3 (Continued)

Variables	Total sample			Physicians and surgeons			Nurses and nurse specialists			Nursing assistants		
	cOr	95% CI	*p*-value	cOr	95% CI	*p*-value	cOr	95% CI	*p*-value	cOr	95% CI	*p*-value
Yes	1.00			1.00			1.00			1.00		
No	1.24	0.86–1.79	.259	0.86	0.49–1.53	.610	2.22	1.17–4.21	.015	1.18	0.46–3.01	.737
Use of computer outside work												
No	1.00			1.00			1.00			1.00		
Yes	1.52	1.01–2.29	.045	1.78	0.56–5.62	.329	1.38	0.78–2.44	.276	2.26	1.05–4.88	.038

Abbreviations: CI, confidence interval; cOR, crude odds ratio.

night work, the use of a VDT at work for more than 4 h a day, and computer exposure outside of work were related to a significant increase in the CVS. However, these relationships must be specified for each occupational group. For physicians and surgeons, the factors significantly increasing the CVS were female sex, the use of ophthalmic or contact lenses, and morning shifts plus on-calls. For nurses and nurse specialists, a 10–20 years seniority, the use of a VDT at work and finding difficulties with the use of the software are related to a significant increase in the CVS. For nursing assistants, a significant relationship was found only in the use of computers outside of work.

To quantify the extent of these relationships (aORs and 95% confidence interval), Table 4 shows the multivariate analysis, where all the variables were included as predictors. In the entire sample of health personnel, female sex (aOR = 2.73; 95% CI 1.76–4.23; $p < .001$), the use of ophthalmic lenses (aOR = 1.88; 95% CI 1.22–2.89; $p = .004$), a 10–20 years seniority (aOR = 1.66; 95% CI 1.01–2.71; $p = .044$), rotating shifts including nights (aOR = 1.70; 95% CI 1.12–2.59; $p = .013$), a use of a VDT at work for 2–4 h/day (aOR = 2.12; 95% CI 1.15–3.92; $p = .016$) and for more than 4 h/day (aOR = 2.40; 95% CI 1.33–4.35; $p = .004$), difficulties in using the software application (aOR = 1.55; 95% CI 1.02–2.35; $p = .042$) and a computer exposure outside work (aOR = 1.77; 95% CI 1.12–2.80; $p = .014$) were related to a significant increase in the CVS. According to the Hosmer–Lemeshow test ($p = .634$), the AUC (0.638), and the Omnibus test ($p < .001$), this model showed that the relationships in entire sample were significant; however, these relationships need to be specified for each occupational group.

Among the physicians and surgeons, the CVS was associated with female sex (aOR = 2.57; 95% CI 1.36–4.88; $p = .004$) and morning shifts plus on-call (aOR = 2.33; 95% CI 1.11–4.88; $p = .025$). The physicians and surgeons with these characteristics were more than twice as likely to suffer from the CVS (Table 4). This model, which considered physicians and surgeons, fitted well according to the Hosmer–Lemeshow test ($p = .801$), the AUC (0.658), and the Omnibus test ($p = .004$).

Among the nurses, the CVS was related to female sex (aOR = 2.35; 95% CI 1.03–5.37; $p = .042$), a 10–20 years seniority (aOR = 2.17; 95% CI 1.03–4.59; $p = .043$), 2–4 h/day use of VDT at work (aOR = 6.14; 95% CI 1.08–35.02; $p = .041$) or more than 4 h/day use of VDT at work (aOR = 7.14; 95% CI 1.29–39.62; $p = .025$), and difficulties in using the software application (aOR = 2.49; 95% CI 1.23–5.01; $p = .012$). The nurses and nurse specialists were more than twice as likely to suffer from the CVS (Table 4). This model, which considered nurses and nurse specialists, fitted well according to the Hosmer–Lemeshow test ($p = .913$), the AUC (0.677), and the Omnibus test ($p < .001$).

Among the nursing assistants, the only relationship that was observed was with the use of computers outside of work (aOR = 2.46; 95% CI 1.05–5.78; $p = .038$; Table 4). However, according to the Omnibus test ($p = .486$) and in contrast with the other occupational groups, this model was not significant.

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 4 Logistic regression model of predictors of the CVS: demographic, individual and work factors

	Total sample			Physicians and surgeons			Nurses and nurse specialists			Nursing assistants		
Variables	aOr	95% CI	*p*-value	aOr	95% CI	*p*-value	aOr	95% CI	*p*-value	aOr	95% CI	*p*-value
Sex												
Male	1.00			1.00			1.00			1.00		
Female	2.73	1.76–4.23	<.001	2.57	1.36–4.88	.004	2.35	1.03–5.37	.042	1.30	0.14–11.67	.818
Age (years)												
≤35	1.00			1.00			1.00			1.00		
36 to ≤45	1.18	0.67–2.06	.569	1.49	0.49–4.53	.482	1.42	0.65–3.08	.381	0.70	0.13–3.77	.680
>45	1.50	0.80–2.81	.207	2.88	0.67–12.40	.157	2.42	0.91–6.45	.078	0.91	0.17–4.91	.912
Ophthalmic lens wearers												
No	1.00			1.00			1.00			1.00		
Yes	1.88	1.22–2.89	.004	2.17	0.93–5.04	.072	1.73	0.91–3.30	.096	1.95	0.69–5.52	.207
Contact lens wearers												
No	1.00			1.00			1.00			1.00		
Yes	1.51	0.89–2.57	.123	1.93	0.81–4.58	.138	1.74	0.76–3.98	.189	0.87	0.20–3.81	.852
Hospital												
HUCA	1.00			1.00			1.00			1.00		
HMN	1.13	0.73–1.76	.583	0.97	0.42–2.23	.935	1.08	0.59–1.98	.794	1.28	0.24–6.83	.770
Seniority (years)												
≤10	1.00			1.00			1.00			1.00		
>10 to ≤20	1.66	1.01–2.71	.044	1.26	0.44–3.64	.668	2.17	1.03–4.59	.043	1.23	0.44–3.42	.692
>20	0.65	0.37–1.16	.143	0.65	0.18–2.36	.515	0.48	0.19–1.21	.120	0.45	0.15–1.39	.167
Work schedule												
Day shifts only	1.00			1.00			1.00			1.00		
Rotating shifts including nights	1.70	1.12–2.59	.013	2.32	0.50–10.86	.285	1.44	0.81–2.57	.221	1.52	0.57–4.02	.401
Morning shifts plus on-call	1.41	0.86–2.32	.175	2.33	1.11–4.88	.025	1.66	0.48–5.67	.422	–	–	–
Use of VDT at work (h/day)												
<2	1.00			–	–	–	1.00			1.00		
2 to ≤4	2.12	1.15–3.92	.016	1.00			6.14	1.08–35.02	.041	1.28	0.52–3.20	.592
>4	2.40	1.33–4.35	.004	0.95	0.45–2.01	.883	7.14	1.29–39.62	.025	1.85	0.65–5.25	.248
Easy software application												

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 4 (Continued)

Variables	Total sample aOr	Total sample 95% CI	Total sample p-value	Physicians and surgeons aOr	Physicians and surgeons 95% CI	Physicians and surgeons p-value	Nurses and nurse specialists aOr	Nurses and nurse specialists 95% CI	Nurses and nurse specialists p-value	Nursing assistants aOr	Nursing assistants 95% CI	Nursing assistants p-value
Yes	1.00			1.00			1.00			1.00		
No	1.55	1.02–2.35	.042	0.97	0.50–1.91	.939	2.49	1.23–5.01	.012	1.30	0.45–3.78	.628
Use of computer outside work												
No	1.00			1.00			1.00			1.00		
Yes	1.77	1.12–2.80	.014	1.81	0.49–6.65	.373	1.69	0.89–3.27	.113	2.46	1.05–5.78	.038
Hosmer–Lemeshow test		*p* = .634			*p* = .801			*p* = .913			*p* = .262	
Area under curve		AUC = 0.638			AUC = 0.658			AUC = 0.677			AUC = 0.595	
Omnibus test		*p* < .001			*p* = .004			*p* < .001			*p* = .486	

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

4 | DISCUSSION

Our study is the first to estimate the prevalence of the CVS in health workers who use VDTs in their workplace and to analyse whether there were differences in this syndrome between the occupational groups. Much of the research to date has focused on workers in other areas such as office personnel, bank employees, and information technology workers (Assefa et al., 2017; Cheng et al., 2019; Ostrovsky et al., 2012; Robertson et al., 2016; Uchino et al., 2018). In addition, a notable strength of our study was the use of a validated questionnaire to measure the CVS, which added greater rigour to our results, compared to previous studies (Larese Filon et al., 2019; Rahman & Sanip, 2011; Ranasinghe et al., 2016; Sa et al., 2012). Furthermore, to make the population under study more representative and to make inferences in each stratum to enable comparisons between them, we selected participants from HUCA using a stratified random sampling method from among the strata of physicians and surgeons, nurses, and nursing assistants.

The main findings of this study estimated a 56.75% prevalence of CVS among healthcare workers. A comparison of the prevalence of the CVS in healthcare workers estimated in this study with that of previous studies that used the same measurement instrument (CVS-Q©) in other target populations showed a similar prevalence (53%) in civil service office workers (Tauste et al., 2016) and a much higher prevalence (74.3%) in presbyopic university workers (Sánchez-Brau et al., 2020). The differences with the latter study (Sánchez-Brau et al., 2020) may be due to the particular characteristics of its participants, since it was a sample of workers over 45 years of age who used a computer for more than 4 h/day during their workday and at least 5 days/week; they were habitual users of progressive addition lenses in the workplace.

In contrast, the prevalence of eye strain in healthcare workers observed in this study was higher than the prevalence of eye strain (36%) that was observed by radiologists Vertinsky and Forster (2005) who evaluated eye strain using a single item in a Likert-type scale with five response options.

Despite the fact that no statistically significant differences were observed between the three occupational groups analysed in this study, the nurses had a higher prevalence of the CVS. The high percentage of women in this occupational group, more than half of whom reported using a VDT for more than 4 h a day at work, may explain these results. Being a woman was one of the factors associated with a higher prevalence of ocular and visual symptoms in numerous studies (Sa et al., 2012; Sánchez-Brau et al., 2020; van Tilborg et al., 2017). Likewise, the possible relationship between the number of hours of computer use at work and a greater risk of visual fatigue, the CVS, or the presence of dry eye disease (DED) has been identified in other studies (Larese Filon et al., 2019; Tauste et al., 2016; Uchino et al., 2013). Furthermore, Artime Ríos et al. (2020) pointed out that working as a nurse was associated with the CVS in a study using artificial intelligence techniques to identify the characteristics of workers most relevant to the appearance of this syndrome.

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

4.1 | CVS in physicians and surgeons

According to the multivariate logistic model, in this occupational group, women had more than double the probability of suffering from the CVS (aOR = 2.57; 95% CI 1.36–4.88; $p = .004$). In their study on a sample of radiologists, Vertinsky and Forster (2005) observed that the female sex was an independent predictor of increased eye strain symptoms ($p < .001$) even when adjusted for the length of the work day. In a study on paramedical workers in Korea, Hyon et al. (2019) identified the female sex as a potential risk factor for DED (aOR = 4.53; 95% CI 1.65–12.42; $p = .003$), and their figures were higher than those of this study. However, since they did not distinguish between nurses and medical technicians when performing their statistical analysis, and the tasks and characteristics such as skills or responsibilities of the latter could not be considered similar to those of the physicians and surgeons in this study.

About the effect of the work shift on the self-perceived ocular and visual symptomatology by physicians and surgeons, our findings indicated that the probability of a CVS increased when the work schedule was morning shifts plus on-call as compared to day shifts only. In the first case, the professionals worked a fixed shift in the morning and on certain days they were on duty for 24 h. These results may have been due either to the influence of night-time work or to the long hours of work that exceeded 8 h a day. Makateb and Torabifard (2017) studied the effects of night-time work on dry eye signs and symptoms in a sample of medical and security staff from a hospital and discovered that night-time work can cause tear film instability and the exacerbation of dry eye symptoms. Meanwhile, Castellanos-González et al. (2016) studied the prevalence of DED in medical residents of surgical specialties and found that 67% of the individuals reported symptoms during an on-call shift, which was lower in the case of a working day of 8 h.

It is important to note the lack of a statistically significant association between the greater use of VDTs at work and CVS among physicians and surgeons, since they are the most exposed occupational group. A recent review on CVS in radiologists concluded that the long hours of facing computer monitors made the work of radiologists similar to that of computer professionals; hence, they also shared similar occupational hazards; therefore, excessive exposure to computers in this group can be considered to be harmful (Chawla et al., 2019). Further studies that analyse the type of hospital services in which the prevalence of the syndrome rises as the hours of VDT use increase are recommended.

4.2 | CVS in nurses

Being a woman also doubles the probability of experiencing the CVS in nurses. In addition, a seniority between 10 and 20 years is another factor that affects the CVS in this occupational group. We have also verified that the highest use of VDTs at work in our sample of nurses lies in this range of seniority. Nevertheless, no other study has established a significant relationship with CVS for this range of seniority. Ranasinghe et al. (2016) found that those with severe CVS had a longer duration of occupation than those with mild to moderate CVS. In contrast, other studies did not find any relationship between working seniority and an increase in ocular and visual symptoms (Dessie et al., 2018; Larese Filon et al., 2019).

Our results indicated that nurses who used VDTs at work for 2 h or more were more than six times more likely to suffer from CVS, which represented the great influence of this risk factor. Numerous studies have associated the number of hours of VDT use at work with ocular and visual symptoms (Agarwal et al., 2013; Hyon et al., 2019; Tauste et al., 2016), while very few do not establish this relationship (Bhanderi et al., 2008; Sánchez-Brau et al., 2020), although none of these studies were conducted on health personnel samples. Furthermore, Hyon et al. (2019) observed a possible association between the prolonged use of computers and DED in paramedical workers and Agarwal et al. (2013) observed a significant difference in the prevalence of asthenopia between subjects working at computer terminals for less than 6 h and those working for more than 6 h a day. This was consistent with the results of Tauste et al. (2016), who found a considerable increase in the CVS in civil service office workers wearing contact lenses who spent more than 6 h a day working with VDT (aOR = 4.85; 95% CI 1.25–18.80; $p = .02$). However, our results for nurses were even more overwhelming than those of Tauste et al. (2016). The fact that the working time with VDTs affects nurses much more than physicians and surgeons may be due to differences in the ergonomic aspects of the workplace according to occupational groups, which have not been evaluated in this study. For example, in both hospitals, in the setting of this study, nurses used medicine distribution computer carts which are not easy to modify in terms of the height or tilt of the screen, while physicians and surgeons use laptop computer carts where these adjustments are simpler. Moreover, physicians and surgeons spend more time out of the patient wards using desktop computers, than nurses. Future studies that evaluate the ergonomics of the jobs of nurses using medicine distribution computer carts will enable an understanding of whether the display placement induces inappropriate vision angles that force them to adopt awkward neck postures that may worsen the syndrome (Sánchez-Brau et al., 2020).

Difficulties in handling the software applications (which require high concentration and intense visual demands) were another risk factor for the CVS in the nurse group. Our results suggested that more demanding cognitive tasks carried a greater risk of experiencing the CVS (Anshel, 2005). A review on the implementation of EHRs in hospitals (Boonstra et al., 2014) and a study in Jordan (Tubaishat, 2017) that evaluated the effectiveness of EHRs from a nursing perspective, indicated that the use of EHRs reduces the levels of uncertainty and disturbance for users, resulting in a more positive attitude toward this information system. Since nurses favour the use of EHRs and are satisfied with them and perceive their high quality, the ongoing implementation of EHRs should be encouraged. It should be noted that the nurses surveyed in the work

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

by Tubaishat (2017) were younger (mean = 30.0, *SD* 6.16 years) than those in our study, and they had a lower seniority in their job (mean = 7.62, *SD* 6.01 years). When analysing our data, it was observed that 82.09% of the youngest nurses (≤35 years) and 85.88% of those with a lower seniority (≤10 years) reported not having difficulties in the use of the software applications, which may have been due to their higher familiarity with new information and communication technologies.

4.3 | CVS in nursing assistants

Our results indicated a scarce use of VDTs at work in the group of nursing assistants (mean = 2.72, *SD* 2.31 h/day), and the multivariate analysis revealed only a relationship between the CVS and the use of computers outside work (aOR = 2.46; 95% CI 1.05–5.78; $p = .038$). In fact, a high percentage of workers belonging to this group (31.11%) were excluded because they did not use computers in their workplace.

In Spain and other countries, the nursing profession has been traditionally considered to be a typically female-dominated occupation (Bernabeu-Mestre et al., 2013; Kowalczuk et al., 2018). This may explain the high proportion of women in this group (96.97%) and in the nurse group (88.77%), with respect to the group of physicians and surgeons (54.15%). At present, this is changing with an increasing masculinization of the occupation. This phenomenon is related to good career projections, an ample job field, good salaries, and the scientific-humanist professional character of the present era of nursing (Osses-Paredes et al., 2010).

4.4 | Limitations

This study has several limitations. First, the refractive states of the participants in this study were not determined. Uncorrected refractive errors, especially astigmatism, increase VDT-related symptoms (Rosenfield, 2011; Sheppard & Wolffsohn, 2018). Second, the use outside of the work of mobile phones or other electronic devices other than computers was not taken into consideration. Third, despite the differences in their job content, physicians and surgeons were considered as a single stratum for the selection of the sample size, which is why we did not study the CVS and its related factors separately. In future studies, a larger sample size of surgeons (only 35 in the current sample) may allow for separate treatment, that may provide more valuable and specific information. Finally, due to the limitations inherent in a cross-sectional design, further longitudinal studies are required, to investigate the visual problems associated with long-term VDT exposure. However, this study can be considered as the first approach to the problem, serving as a starting point for the development of new research focusing on the implications of aspects such as the types of digital devices used, the ergonomic characteristics of the workplaces, and the visual characteristics of the workers.

5 | CONCLUSIONS

Healthcare workers are more susceptible to the CVS. Nurses showed the highest prevalence of the CVS, especially women, with a seniority of between 10 and 20 years, a longer exposure to VDTs at work, and the experience of difficulties with the use of the software applications. Female sex and morning shifts plus on-call were associated with a higher prevalence of the CVS in physicians and surgeons. With the increasing implementation of EHRs in hospitals, further studies that include visual examinations and ergonomic evaluations are needed. Moreover, the evaluation of the effects of VDTs on visual health has become more important with their increasing use due to the SARS-CoV-2 pandemic. It is clear that in the future, digital devices will continue to be essential for evaluating, diagnosing, and treating patients at a distance. Therefore, addressing such aspects can increase the likelihood of successfully implementing EHR systems and minimizing the risks to the ocular health of these workers.

ACKNOWLEDGEMENTS

The authors would like to thank the hospital management board for allowing us to carry out the study. We would also like to thank the supervisors and middle managers of both participating hospitals, as well as all the members of the nursing training department of the Central University Hospital of Asturias, for their support. Finally, we would like to acknowledge all the health personnel who participated in the study for their contributions and for taking their time to answer the questionnaires.

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

AUTHOR CONTRIBUTIONS

Eva Artime-Ríos, Ana Suárez-Sánchez and Mar Seguí-Crespo, conceptualized and designed the study; Eva Artime-Ríos was involved in data collection; Eva Artime-Ríos, Mar Seguí-Crespo and Fernando Sánchez-Lasheras performed the analyses and interpretation of the data; Eva Artime-Ríos and Mar Seguí-Crespo drafted the initial manuscript; all authors provided critical revision of the draft, revised and approved the final manuscript; all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

PEER REVIEW

The peer review history for this article is available at https://publons.com/publon/10.1111/jan.15140.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are not publicly available to preserve individuals' privacy under the European General Data Protection Regulation and the Spanish Organic Act 3/2018 on Personal Data Protection (BOE 294, 6 Dec., 2018). Participants of this study did not agree for their data to be shared publicly, so neither the data nor the source of the data can be made available.

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

ORCID

Eva Artime-Ríos https://orcid.org/0000-0003-0614-3881

TWITTER

Eva Artime-Ríos @Eva_Artime

REFERENCES

Aakre, B. M., & Doughty, M. J. (2007). Are there differences between "visual symptoms" and specific ocular symptoms associated with video display terminal (VDT) use? *Contact Lens and Anterior Eye*, *30*(3), 174–182. https://doi.org/10.1016/j.clae.2007.01.001

Agarwal, S., Goel, D., & Sharma, A. (2013). Evaluation of the factors which contribute to the ocular complaints in computer users. *Journal of Clinical and Diagnostic Research*, *7*(2), 331–335. https://doi.org/10.7860/JCDR/2013/5150.2760

Anshel, J. R. (2005). *Visual ergonomics handbook* (1st ed.) Taylor & Francis Group. https://doi.org/10.1201/9781420032055

AOA. (2020). *Computer vision syndrome*. American Optometric Association. https://www.aoa.org/patients-and-public/caring-for-your-vision/protecting-your-vision/computer-vision-syndrome

Artime Ríos, E. M., Sánchez Lasheras, F., Suárez Sánchez, A., Iglesias-Rodríguez, F. J., & Seguí Crespo, M. D. M. (2019). Prediction of computer vision syndrome in health personnel by means of genetic algorithms and binary regression trees. *Sensors*, *19*(12), 2800. https://doi.org/10.3390/s19122800

Artime Ríos, E. M., Suárez Sánchez, A., Sánchez Lasheras, F., & del Seguí Crespo, M. M. (2020). Genetic algorithm based on support vector machines for computer vision syndrome classification in health personnel. *Neural Computing and Applications*, *32*(5), 1239–1248. https://doi.org/10.1007/s00521-018-3581-3

Assefa, N. L., Weldemichael, D. Z., Alemu, H. W., & Anbesse, D. H. (2017). Prevalence and associated factors of computer vision syndrome among bank workers in Gondar city, northwest Ethiopia, 2015. *Clinical Optometry*, *9*, 67–76. https://doi.org/10.2147/OPTO.S126366

Bernabeu-Mestre, J., Carrillo-García, C., Galiana-Sánchez, M. E., García-Paramio, P., & Trescastro-López, E. M. (2013). Gender and profession in the historical development of community nursing in Spain. *Enfermeria Clinica*, *23*(6), 284–289. https://doi.org/10.1016/j.enfcli.2013.07.005

Bhanderi, D. J., Choudhary, S., & Doshi, V. G. (2008). A community-based study of asthenopia in computer operators. *Indian Journal of Opthalmology*, *56*(1), 51–55. https://doi.org/10.4103/0301-4738.37596

BOE 128, 29 May. (2003). *Ley 16/2003, de 28 de mayo, de cohesión y calidad del Sistema Nacional de Salud*. BOE (Boletín Oficial del Estado), Identifier: BOE-A-2003-10715. https://www.boe.es/eli/es/l/2003/05/28/16/con

BOE 274, 15 Nov. (2002). *Ley 41/2002, de 14 de noviembre, básica reguladora de la autonomía del paciente y de derechos y obligaciones en materia de información y documentación clínica*. BOE (Boletín Oficial del Estado), Identifier: BOE-A-2002-22188. https://www.boe.es/eli/es/l/2002/11/14/41/con

BOE 294, 6 Dec. (2018). *Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales*. BOE (Boletín Oficial del Estado), Identifier: BOE-A-2018-16673. https://www.boe.es/eli/es/lo/2018/12/05/3/con

BOE 97, 23 Apr. (1997). *Real Decreto 488/1997, de 14 de abril, sobre disposiciones mínimas de seguridad y salud relativas al trabajo con equipos que incluyen pantallas de visualización*. BOE (Boletín Oficial del Estado), Identifier: BOE-A-1997-8671. https://www.boe.es/eli/es/rd/1997/04/14/488

Boonstra, A., Versluis, A., & Vos, J. F. J. (2014). Implementing electronic health records in hospitals: A systematic literature review. *BMC Health Services Research*, *14*, 370. https://doi.org/10.1186/1472-6963-14-370

Castellanos-González, J. A., Torres-Martínez, V., Martínez-Ruiz, A., Fuentes-Orozco, C., Rendón-Félix, J., Irusteta-Jiménez, L., Márquez-Valdez, A. R., Cortés-Lares, J. A., & González-Ojeda, A. (2016). Prevalence of dry eye syndrome in residents of surgical specialties. *BMC Ophthalmology*, *16*, 108. https://doi.org/10.1186/s12886-016-0292-3

Castro, J. S., Selegatto, I. B., Castro, R. S., Miranda, E. C. M., de Vasconcelos, J. P. C., de Carvalho, K. M., Arieta, C. E. L., & Alves, M. (2018). Prevalence and risk factors of self-reported dry eye in Brazil using a short symptom questionnaire. *Scientific Reports*, *8*(1), 2076. https://doi.org/10.1038/s41598-018-20273-9

Chawla, A., Lim, T. C., Shikhare, S. N., Munk, P. L., & Peh, W. C. G. (2019). Computer vision syndrome: Darkness under the shadow of light. *Canadian Association of Radiologists Journal*, *70*(1), 5–9. https://doi.org/10.1016/j.carj.2018.10.005

Cheng, X., Song, M., Kong, J., Fang, X., Ji, Y., Zhang, M., & Wang, H. (2019). Influence of prolonged visual display terminal use and exercise on physical and mental conditions of internet staff in Hangzhou, China. *International Journal of Environmental Research and Public Health*, *16*(10), 1829. https://doi.org/10.3390/ijerph16101829

Dessie, A., Adane, F., Nega, A., Wami, S. D., & Chercos, D. H. (2018). Computer vision syndrome and associated factors among computer users in Debre Tabor town, Northwest Ethiopia. *Journal of Environmental and Public Health*, *2018*, 1–8. https://doi.org/10.1155/2018/4107590

Eurofound. (2017). *Sixth European working conditions survey – Overview report (2017 update)*. Publications Office of the European Union. https://doi.org/10.2806/422172

Fenga, C., Aragona, P., Cacciola, A., Spinella, R., Di Nola, C., Ferreri, F., & Rania, L. (2008). Meibomian gland dysfunction and ocular discomfort in video display terminal workers. *Eye*, *22*(1), 91–95. https://doi.org/10.1038/sj.eye.6703025

Girum, M., Gudeta, A. D., & Alemu, D. S. (2017). Determinants of high unmet need for presbyopia correction: A community-based study in northwest Ethiopia. *Clinical Optometry*, *9*, 25–31. https://doi.org/10.2147/OPTO.S123847

Hyon, J. Y., Yang, H. K., & Han, S. B. (2019). Association between dry eye disease and psychological stress among paramedical workers in Korea. *Scientific Reports*, *9*(1), 3783. https://doi.org/10.1038/s41598-019-40539-0

Jackson, A. J., Barnett, E. S., Stevens, A. B., McClure, M., Patterson, C., & McReynolds, M. J. (1997). Vision screening, eye examination and risk assessment of display screen users in a large regional teaching hospital. *Ophthalmic and Physiological Optics*, *17*(3), 187–195. https://doi.org/10.1111/j.1475-1313.1997.0_853.x

Jaiswal, S., Asper, L., Long, J., Lee, A., Harrison, K., & Golebiowski, B. (2019). Ocular and visual discomfort associated with smartphones, tablets and computers: What we do and do not know. *Clinical and Experimental Optometry*, *102*(5), 463–477. https://doi.org/10.1111/cxo.12851

Jaschinski, W., König, M., Mekontso, T. M., Ohlendorf, A., & Welscher, M. (2015). Computer vision syndrome in presbyopia and beginning presbyopia: Effects of spectacle lens type. *Clinical and Experimental Optometry*, *98*(3), 228–233. https://doi.org/10.1111/cxo.12248

Klamm, J., & Tarnow, K. G. (2015). Computer vision syndrome: A review of literature. *MEDSURG Nursing*, *24*(2), 89–93.

Kowalczuk, K., Krajewska-Kulak, E., & Sobolewski, M. (2018). Psychosocial hazards in the workplace as an aspect of horizontal segregation in the nursing profession. *Frontiers in Psychology*, *9*, 2042. https://doi.org/10.3389/fpsyg.2018.02042

Larese Filon, F., Drusian, A., Ronchese, F., & Negro, C. (2019). Video display operator complaints: A 10-year follow-up of visual fatigue and refractive disorders. *International Journal of Environmental Research and Public Health*, *16*(14), 2501. https://doi.org/10.3390/ijerph16142501

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Lurati, A. R. (2018). Computer vision syndrome: Implications for the occupational health nurse. *Workplace Health & Safety*, *66*(2), 56–60. https://doi.org/10.1177/2165079917731790

Makateb, A., & Torabifard, H. (2017). Dry eye signs and symptoms in night-time workers. *Journal of Current Ophthalmology*, *29*(4), 270–273. https://doi.org/10.1016/j.joco.2017.05.003

Morrison, J., & Lindberg, P. (2008). When no one has time: Measuring the impact of computerization on health care workers. *AAOHN Journal*, *56*(9), 373–378. https://doi.org/10.3928/08910162-20080901-06

Osses-Paredes, C., Valenzuela Suazo, S., & Sanhueza Alvarado, O. (2010). Men at the nursing profession. *Enfermería Global*, *18*, 1–7. https://doi.org/10.4321/s1695-61412010000100016

Ostrovsky, A., Ribak, J., Pereg, A., & Gaton, D. (2012). Effects of job-related stress and burnout on asthenopia among high-tech workers. *Ergonomics*, *55*(8), 854–862. https://doi.org/10.1080/00140139.2012.681808

Rahman, Z. A., & Sanip, S. (2011). Computer user: Demographic and computer related factors that predispose user to get computer vision syndrome. *International Journal of Business, Humanities and Technology*, *1*(2), 84–91.

Ranasinghe, P., Wathurapatha, W. S., Perera, Y. S., Lamabadusuriya, D. A., Kulatunga, S., Jayawardana, N., & Katulanda, P. (2016). Computer vision syndrome among computer office workers in a developing country: an evaluation of prevalence and risk factors. *BMC Research Notes*, *9*(1), 150. https://doi.org/10.1186/s13104-016-1962-1

Robertson, M. M., Huang, Y., & Larson, N. (2016). The relationship among computer work, environmental design, and musculoskeletal and visual discomfort: Examining the moderating role of supervisory relations and co-worker support. *International Archives of Occupational and Environmental Health*, *89*(1), 7–22. https://doi.org/10.1007/s00420-015-1046-x

Rosenfield, M. (2011). Computer vision syndrome: A review of ocular causes and potential treatments. *Ophthalmic and Physiological Optics*, *31*(5), 502–515. https://doi.org/10.1111/j.1475-1313.2011.00834.x

Rossi, G. C. M., Scudeller, L., Bettio, F., Pasinetti, G. M., & Bianchi, P. E. (2019). Prevalence of dry eye in video display terminal users: A cross-sectional caucasian study in Italy. *International Ophthalmology*, *39*(6), 1315–1322. https://doi.org/10.1007/s10792-018-0947-6

Rozanova, O. I., Shchuko, A. G., & Mischenko, T. S. (2018). Fundamentals of presbyopia: Visual processing and binocularity in its transformation. *Eye and Vision*, *5*, 1. https://doi.org/10.1186/s40662-018-0095-0

Sa, E. C., Ferreira Junior, M., & Rocha, L. E. (2012). Risk factors for computer visual syndrome (CVS) among operators of two call centers in São Paulo, Brazil. *Work*, *41*(SUPPL.1), 3568–3574. https://doi.org/10.3233/WOR-2012-0636-3568

Sánchez-Brau, M., Domenech-Amigot, B., Brocal-Fernández, F., Quesada-Rico, J. A., & Seguí-Crespo, M. (2020). Prevalence of computer vision syndrome and its relationship with ergonomic and individual factors in presbyopic VDT workers using progressive addition lenses. *International Journal of Environmental Research and Public Health*, *17*(3), 1003. https://doi.org/10.3390/ijerph17031003

Seguí, M. D. M., Cabrero-García, J., Crespo, A., Verdú, J., & Ronda, E. (2015). A reliable and valid questionnaire was developed to measure computer vision syndrome at the workplace. *Journal of Clinical Epidemiology*, *68*(6), 662–673. https://doi.org/10.1016/j.jclinepi.2015.01.015

Sheppard, A. L., & Wolffsohn, J. S. (2018). Digital eye strain: Prevalence, measurement and amelioration. *BMJ Open Ophthalmology*, *3*(1), e000146. https://doi.org/10.1136/bmjophth-2018-000146

Soria-Oliver, M., López, J. S., Torrano, F., García-González, G., & Lara, Á. (2019). New patterns of information and communication technologies usage at work and their relationships with visual discomfort and musculoskeletal diseases: Results of a cross-sectional study of Spanish organizations. *International Journal of Environmental Research and Public Health*, *16*(17), 3166. https://doi.org/10.3390/ijerph16173166

Tauste, A., Ronda, E., Molina, M. J., & Seguí, M. (2016). Effect of contact lens use on computer vision syndrome. *Ophthalmic and Physiological Optics*, *36*(2), 112–119. https://doi.org/10.1111/opo.12275

Tubaishat, A. (2017). Evaluation of electronic health record implementation in hospitals. *CIN: Computers Informatics Nursing*, *35*(7), 364–372. https://doi.org/10.1097/CIN.0000000000000328

Uchino, M., Kawashima, M., Uchino, Y., Tsubota, K., & Yokoi, N. (2018). Association between tear film break up time and blink interval in visual display terminal users. *International Journal of Ophthalmology*, *11*(10), 1691–1697. https://doi.org/10.18240/ijo.2018.10.18

Uchino, M., Yokoi, N., Uchino, Y., Dogru, M., Kawashima, M., Komuro, A., Sonomura, Y., Kato, H., Kinoshita, S., Schaumberg, D. A., & Tsubota, K. (2013). Prevalence of dry eye disease and its risk factors in visual display terminal users: The Osaka study. *American Journal of Ophthalmology*, *156*(4), 759–766. https://doi.org/10.1016/j.ajo.2013.05.040

Ünlü, C., Güney, E., Akçay, B. I. S., Akçali, G., Erdoğan, G., & Bayramlar, H. (2012). Comparison of ocular-surface disease index questionnaire, tearfilm break-up time, and Schirmer tests for the evaluation of the tearfilm in computer users with and without dry-eye symptomatology. *Clinical Ophthalmology*, *6*(1), 1303–1306. https://doi.org/10.2147/OPTH.S33588

van Tilborg, M. M., Murphy, P. J., & Evans, K. S. (2017). Impact of dry eye symptoms and daily activities in a modern office. *Optometry and Vision Science*, *94*(6), 688–693. https://doi.org/10.1097/OPX.0000000000001086

Vertinsky, T., & Forster, B. (2005). Prevalence of eye strain among radiologists: Influence of viewing variables on symptoms. *American Journal of Roentgenology*, *184*(2), 681–686. https://doi.org/10.2214/ajr.184.2.01840681

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2008). The strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. *Journal of Clinical Epidemiology*, *61*(4), 344–349. https://doi.org/10.1016/j.jclinepi.2007.11.008

Yazici, A., Sari, E. S., Sahin, G., Kilic, A., Cakmak, H., Ayar, O., & Ermis, S. S. (2015). Change in tear film characteristics in visual display terminal users. *European Journal of Ophthalmology*, *25*(2), 85–89. https://doi.org/10.5301/ejo.5000525

Ye, Z., Honda, S., Abe, Y., Kusano, Y., Takamura, N., Imamura, Y., Eida, K., Takemoto, T., & Aoyagi, K. (2007). Influence of work duration or physical symptoms on mental health among Japanese visual display terminal users. *Industrial Health*, *45*(2), 328–333. https://doi.org/10.2486/indhealth.45.328

How to cite this article: Artime-Ríos, E. M., Suárez-Sánchez, A., Sánchez-Lasheras, F., & Seguí-Crespo, M. (2022). Computer vision syndrome in healthcare workers using video display terminals: an exploration of the risk factors. *Journal of Advanced Nursing*, 78, 2095–2110. https://doi.org/10.1111/jan.15140

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

The *Journal of Advanced Nursing (JAN)* is an international, peer-reviewed, scientific journal. *JAN* contributes to the advancement of evidence-based nursing, midwifery and health care by disseminating high quality research and scholarship of contemporary relevance and with potential to advance knowledge for practice, education, management or policy. *JAN* publishes research reviews, original research reports and methodological and theoretical papers.

For further information, please visit *JAN* on the Wiley Online Library website: www.wileyonlinelibrary.com/journal/jan

Reasons to publish your work in *JAN*:

- **High-impact forum: the world's most cited nursing journal, with an Impact Factor of 2.561 – ranked 6/123 in the 2019 ISI Journal Citation Reports © (Nursing; Social Science).**
- **Most read nursing journal in the world: over 3 million articles downloaded online per year and accessible in over 10,000 libraries worldwide (including over 6,000 in developing countries with free or low cost access).**
- **Fast and easy online submission:** online submission at http://mc.manuscriptcentral.com/jan.
- **Positive publishing experience:** rapid double-blind peer review with constructive feedback.
- **Rapid online publication in five weeks:** average time from final manuscript arriving in production to online publication.
- **Online Open:** the option to pay to make your article freely and openly accessible to non-subscribers upon publication on Wiley Online Library, as well as the option to deposit the article in your own or your funding agency's preferred archive (e.g. PubMed).

13652648, 2022, 7, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jan.15140 by Spanish Cochrane National Provision (Ministerio de Sanidad), Wiley Online Library on [09/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License