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Risk factors of computer vision syndrome in students during online learning period

Reva Maya Tika[1], Laila Fitria[2]
[1]Bachelor of Environmental Health Program, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia
[2]Department of Environmental Health, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia

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ABSTRACT

The COVID-19 pandemic poses a risk of increasing cases of computer vision syndrome (CVS) due to changes in the environment for work and study because of the implementation of the Work/Study from Home policy. This study aimed to determine the risk factors associated with CVS in students. The study design was cross-sectional with the population of bachelor program students, with a sample size of 124 students. Data were collected through online questionnaires. Data analysis was carried out to study the statistical relationship between the independent variables and the dependent variable using the Chi-Square test. This study showed that the prevalence of CVS among students was 87.1%. The analysis showed that one variable had a significant relationship with CVS in students, namely emotional exhaustion (OR 5.47, 95% CI: 1.75-17.02). Another variable, although not significant, was considered to play a role as a risk factor for CVS, namely the duration of computer use (OR 4.75, 95% CI: 1.02-22.25). Emotional exhaustion and duration of computer use are important risk factors in the occurrence of CVS in students during the online learning period. It is necessary to increase socialization regarding the ergonomics of using computers and stress management to prevent CVS in students.

Corresponding Author:

Laila Fitria
Department of Environmental Health, Faculty of Public Health, Universitas Indonesia
Depok 16424, West Java, Indonesia
Email: lfitria@ui.ac.id

1. INTRODUCTION

During the COVID-19 pandemic, the use of computers became very important because of the implementation of work/study from home (WFH) and Distance Learning. All work is attempted to be done from home (remotely) including teaching and learning activities. So that all workers including students carried out online activities with computers as support. This has led to an increase in computer use compared to the pre-pandemic period. A survey in Canada reported that people spending more hours per day (8.35 hours) using technology during the pandemic compared to prior (6.02 hours) [1].

The increasing use of computers will also increase the risk of negative impacts, especially health impacts. One of the health impacts caused by the use of computers is computer vision syndrome (CVS). Computer Vision Syndrome, also known as Digital Eye Strain, is a group of problems related to eyes and vision due to improper use of computers, laptops, cell phones, and other devices. Some of the symptoms that indicate the occurrence of CVS are eye strain, which is characterized by sore eyes, headaches, blurred vision, dry eyes, and pain in the neck and shoulders [2]. Regular use of computer equipment for long periods of time will cause CVS symptoms to occur repeatedly with increasingly severe symptoms [3].

Computer vision syndrome (CVS) relates to visual display terminal (VDT), where VDT is present on computers and similar technologies, such as on computer monitors, laptops, and tablets. The prevalence of CVS in VDT users is estimated at 64-90%, with 60 million sufferers worldwide. Every year there are 1 million new cases of CVS [4]. A survey conducted during the pandemic showed that there was an increase in the incidence of CVS by 60% in July 2020 [1]. A previous study in Spain found that the prevalence of CVS in administrative workers was 74.3% [5]. The prevalence for the Asian region, a study on medical students in India found a CVS prevalence of 85%, and a study on students majoring in business and medicine in Saudi Arabia found a CVS prevalence of 58.41% [6], [7]. While the prevalence of CVS in Indonesia can be seen from several studies, including research conducted on computer science students, with a CVS prevalence of 69.9% [8]. In another study, it was also found that the prevalence of CVS in workers was 60% [9]. From several previous studies with the working population and students, it appears that the prevalence of CVS in students is higher than in workers.

The effects of CVS are unlikely to be permanent, but they will still impair performance if symptoms recur [10]. The severity and type of symptoms that arise will depend on the duration, and individual behavior towards computer use, the type of activity in the form of visual loads, the physical environment, and the condition of the visual abilities of each individual [11].

The pathophysiology of CVS is caused by the human eye's inability to focus for a long time on objects on a computer screen [12]. Objects on a computer are made up of pixels that are generated from electronic beams on a screen. This causes each pixel to have a decreasing brightness level from the center to all the edges. This makes it difficult for the human eye to focus because the human eyes cannot sustain focus on the pixel characters [13]. Stress, anxiety, depression, and sleep disturbance are also associated with dry eye disease, especially during COVID-19 [14].

Many factors can affect the occurrence of dry eye, as one of the CVS symptoms, including gender, age, the distance between eyes and screen, eye position against the screen, room lighting, screen position, screen contrast, length of computer use, rest time after computer use, use of glasses or contact lenses, humidity, number of eye blinks per minute, and sitting position when using the computer [15]. In previous studies, the factors that had a significant relationship with the occurrence of CVS in students were computer use of more than four hours per day, room lighting, screen lighting, and eye distance to the computer screen [6], [16]. The use of glasses was also found to have a significant relationship with the occurrence of CVS [17]. The viewing angle of the computer screen is also a significant risk factor for the occurrence of CVS [8].

The Faculty of Public Health (FPH) Universitas Indonesia (UI) is an educational institution that implemented the distance learning system during the pandemic period. The learning method implemented at FPH UI suddenly changed to an online learning system and lasted for quite a long time, so it was likely to impact the occurrence of health problems for students, especially CVS. Until now, there has been no research that examines the occurrence of CVS and its risk factors in FPH UI students, especially during this pandemic period. Therefore, it was necessary to conduct a study that examines the occurrence of CVS and its risk factors in FPH UI students.

This study aimed to describe the prevalence of CVS and factors associated with the risk of CVS in students of the FPH UI. The factors studied were individual factors (refractive errors, duration of computer use, duration of rest when using computers, emotional exhaustion, and knowledge of ergonomics), environmental factors (room lighting), and computer factors (eye distance to the computer screen, and type of computer), lighting habits, and monitor polarity. The factors chosen to be studied were factors that, in previous studies, were stated as factors related to the occurrence of CVS, and data could be collected through a questionnaire.

The results of this study can contribute to education providers who implement online learning systems in the form of information regarding the risk of CVS occurring in students who undergo online learning systems and the factors that influence them. By knowing the risk of CVS, education providers are expected to take preventive measures so that students can carry out the learning process without experiencing these health problems.

2. RESEARCH METHOD

This study had been reviewed by The Research and Ethics Committee of the Faculty of Public Health, Universitas Indonesia (letter number KET-578/UN2.F10.D11/PPM.00.02/2021).

The study design was cross-sectional. The research population was the students of the Faculty of Public Health, University of Indonesia (FPH UI). The samples taken were FPH UI students from the class of 2018, 2019, and 2020 with inclusion criteria were: still being active students of FPH UI in the year 2021, using a laptop/computer at least two hours per day while undergoing distance learning, and willing to fill out the questionnaire by signing the informed consent. Exclusion criteria in this study included a history of

certain diseases, such as diabetes mellitus, hypertension, Sjogren's syndrome, Meiborn gland dysfunction, vitamin A deficiency, thyroid, arthritis, and trigeminal or facial nerve injuries, and taking antidepressant drugs or hormone injections.

The minimum sample size was determined by the sample size calculation for proportion estimation. With an α value of 5%, a precision of 10%, and a proportion of CVS from previous studies of 60% [18], the minimum sample size was 92 students. The sample size was then increased in anticipation of students who did not send responses so that a sample of 124 students was obtained. The sampling method in this study was simple random sampling with a sample of 43 students from the class of 2018, 39 students from the class of 2019, and 42 students from the class of 2020.

Data was collected by filling out the online questionnaires using Google Forms that was sent through social media networks. The data collected included: individual factors (i.e., duration of computer use, duration of rest between computer use, refractive errors, emotional exhaustion, knowledge of ergonomics), environmental factors (i.e., lighting), and computer factors (i.e., type of computer, distance from eye to computer screen), lighting habits, and monitor polarity. CVS data was collected as the dependent variable through several questions, including eye strain, burning eyes, eye irritation, redness of the eyes, dryness of the eyes, double vision, blurred vision, headaches, neck pain, and shoulder pain. Students were declared to have CVS if they experienced at least 5 of the symptoms in question.

Data were analyzed with statistical software (SPSS). Frequency distribution was used to show the distribution of CVS among students, as well as the distribution of other independent variables. To analyze the association between the independent variables and CVS, bivariate analysis was carried out using the chi-square method. The multivariate analysis was also done using the logistic regression method, but the results were the same as the results of the bivariate analysis.

3. RESULTS AND DISCUSSION

3.1. Prevalence of CVS

Table 1 shows the distribution of computer vision syndrome among FPH UI Students in 2021, and Table 2 shows the distribution of individual characteristics of FPH UI Students studied. The results showed that of 124 students, there were 108 students (87.1%) experienced CVS. The most experienced symptoms were neck pain (96.8%), eye strain (95.2%), headache (93.6%), shoulder pain (92.7%), dry eyes (84.7%), and blurred vision (84.7%).

Compared to previous studies, the prevalence of CVS in this study was quite high. In the previous studies in different locations and/or with different populations, the prevalence of CVS ranged from 60% to 90% [1], [4], [5]. Meanwhile, compared to studies in other locations in the same population, namely university students, the prevalence of CVS obtained from this study was the highest. In a study on students in India, the prevalence of CVS was 85%, while in Saudi Arabia the prevalence was 58.1%, and studies in other locations in Indonesia obtained a prevalence of 69.9% [6]–[8].

Table 1. Distribution of computer vision syndrome among FPH UI students in 2021

	Yes		No	
	N	%	N	%
Computer vision syndrome	108	87.1	16	12.9
Symptom:				
Eye strain	118	95.2	6	4.8
Burning	87	70.2	37	29.8
Irritation	78	62.9	46	37.7
Redness	86	69.4	38	30.7
Dry eye	105	84.7	19	15.3
Double vision	77	62.1	47	37.9
Blurred vision	105	84.7	19	15.3
Headache	116	93.6	8	6.5
Neck pain	120	96.8	4	3.2
Shoulder pain	115	92.7	9	7.3

Table 2. Distribution of individual characteristics of FPH UI students in 2021

Characteristics	Yes		No	
	N	%	N	%
Use of eye drops	17	13.7	107	86.3
Convenience of room lighting	100	80.6	24	19.4
Comfort at room temperature	93	75.0	31	25.0
Comfort against humidity	96	77.4	28	22.6
Participate in training, seminars, and socialization on ergonomics using computers	30	24.2	94	75.8

Blurred vision is one of the complaints that is felt due to CVS. The beginning of the occurrence of blurred vision begins with eye strain. Blurred vision occurs when the eye has difficulty focusing on objects accurately due to decreased visual acuity or lack of visual accommodation [19]. In this study, blurred vision was experienced by most of the students studied (84.7%). While in another study among call center employees, blurred vision was experienced by 34.4% subjects [20].

Complaints such as back pain, neck pain, and shoulder pain are symptoms of CVS related to extraocular [21]. These symptoms appear due to the position of the computer that is too high or too low from the user's eye position, thus affecting the body position in an incorrect state [19]. Neck pain could have an impact on the neck's range of motion. A study among employees showed that there was a significant relationship between CVS and the neck's range of motion, meaning that CVS might cause the neck's range of motion among the employees [22]. A study suggested that workers usually adjust their work posture to the visual comfort they get, and to reduce the problem of pain in the neck and back, computer users can take anticipation by adjusting the position of the computer so that the eyes are at the same level or parallel to the computer screen [23].

Symptoms of CVS related to the ocular surface are generally found with complaints of dry eyes, watery eyes, eye irritation, and problems with contact lenses [21]. Research conducted in Japan found that 10.1% to 21.5% of employees who use computers experience dry eyes, whereby discomfort, dryness, burning, and heaviness in the eyes after using the computer for a long time may be caused by problems related to the ocular surface [24].

A study found that female workers were more at risk of experiencing CVS than male workers [25]. Physiologically, the tear film found in women's eyes relatively or tends to thin out more quickly with age [26]. The thinning of the tear film can cause complaints of dry eyes which is one of the symptoms of computer vision syndrome.

3.2. Risk factors of CVS

Table 3 shows the distribution of computer vision syndrome by individual factors, environmental factors, and computer factors in FPH UI Students in 2021. The results of the analysis of the relationship between individual factors, environmental factors, and computer factors with CVS, showed that there was one variable of individual factors that had a significant relationship with CVS, namely the emotional exhaustion factor with Odds Ratio value: 5.47 (95% CI: 1.75-17.02). Other individual factors did not show a statistically significant relationship. However, even so, these individual factors were considered to play a role as risk factors for CVS events, as indicated by a fairly high Odds Ratio value, namely: duration of computer use per day (OR: 4.75; 95% CI: 1.02-22.25), duration break time between computer use (OR: 1.88; 95% CI: 0.23-15.49), refractive error (OR: 1.29; 95% CI: 0.45-3.70), and ergonomics knowledge (OR: 1.55; 95% CI: 0.53-4.56).

The environmental factor studied was the lighting of the room. The results of the analysis showed that room lighting did not have a statistically significant relationship with the CVS in FPH UI students. Similarly, computer factors, in this study did not show a statistically significant relationship with the incidence of CVS in FPH UI students. Multivariate data analysis was also carried out, but the results were the same as the bivariate analysis, so they are not discussed here.

The results of the bivariate analysis showed that emotional exhaustion was significantly related to the prevalence of CVS in students, with an OR value of 5.47 (95% CI: 1.75-17.02). Students who experienced emotional exhaustion were at risk for CVS 5.47 times higher than students who did not experience emotional exhaustion. Emotional exhaustion was experienced by 66.1% of students. This showed that the distance learning process was not only related to physical conditions but also related to the psychological condition of students, which in turn had consequences in the form of CVS symptoms.

Emotional exhaustion or burnout occurs due to an individual's inability to deal with problems in a social environment such as work, school, or college [14]. During this pandemic, there was a very drastic change in the lecturing environment, where students were required to be able to take lectures online. Changes in environmental conditions, such as places and facilities available for lectures, were currently different for each student. Lecture load and task demands could be one of the causes of burnout. The social environment could also be a factor that can trigger emotional exhaustion. Decreased eye function could occur as a result of a negative response to emotional exhaustion or stress in the individual [17]. All these situations could increase the risk of CVS in individuals who experienced emotional exhaustion.

Based on the results of the study, it was found that most of the students felt comfortable with the temperature (75.0%), humidity (77.4%), and lighting (80.6%) of the room where they underwent their distance learning. However, the high proportion of students who experienced emotional exhaustion indicated that the stress conditions experienced by the students from mild to moderate stress. In this study, the causes and descriptions of individual respondents' conditions related to stress management were not investigated

further. However, efforts to prevent CVS related to emotional exhaustion were needed to be recommended, including socialization efforts related to stress management that could be carried out by the student affairs unit or other related units [27]. In addition, socialization related to maintaining a healthy lifestyle and doing regular physical activity was also necessary to reduce stress and minimize burnout [28].

Table 3. Distribution of computer vision syndrome by individual factors, environmental factors, and computer factors in FPH UI students in 2021

Variable	CVS				Total	OR (95% CI)	p-value
	Yes		No				
	n	%	n	%			
Duration of computer use per day							
- ≥ 4 hours	103	88.8	13	11.2	116	4.75 (1.02-22.25)	0.066
- < 4 hours	5	62.5	3	37.5	8		
Break time between computer use							
- <10 minutes	12	92.3	1	7.7	13	1.88 (0.23-15.49)	1.000
- ≥10 minutes	96	86.5	15	13.5	111		
Refractive error							
- Yes	54	88.5	7	11.5	61	1.29 (0.45-3.70)	0.842
- No	54	85.7	9	14.3	63		
Emotional exhaustion							
- Yes	77	93.9	5	6.1	82	5.47 (1.75-17.02)	0.004
- No	31	73.8	11	26.2	42		
Ergonomics knowledge							
- Low	52	89.7	6	10.3	58	1.55 (0.53-4.56)	0.597
- High	56	84.8	10	15.2	66		
Room lighting							
- Bad	21	100	0	0	21	-	0.072
- Good	87	84.5	16	15.5	103		
Distance from eye to computer screen							
- <50 cm	53	88.3	7	11.7	60	1.24 (0.43-3.57)	0.897
- ≥50 cm	55	85.9	9	14.1	64		
Light setting habits							
- No	4	80.0	1	20.0	5	0.58 (0.06-5.51)	0.505
- Yes	104	87.4	15	12.6	119		
Computer Type							
- Portable computer (laptop)	104	86.7	16	13.3	120	-	1.000
- Personal computer (desktop)	4	100	0	0	4		
Monitor polarity							
- Positive polarity	38	86.4	6	13.6	44	0.91 (0.31-3.68)	1.000
- Negative polarity	70	87.5	10	12.5	80		

The results of the analysis between the variable duration of computer use and CVS showed that there was no statistically significant relationship between the two variables. However, the duration of computer use was considered to play a role as a risk factor for CVS events, as indicated by the OR value of 4.75 (95% CI: 1.02-22.25). Students who used computers for more than four hours a day were at risk for CVS 4.75 times higher than students who used computers for less than four hours a day. Almost all of the students studied used computers for more than four hours a day (93.5%) due to the long lecture time, generally starting from eight in the morning to three in the afternoon, interspersed with one hour break at 12 noon. Even after completing lectures, in general, students would still use computers to do college assignments.

Previous research has also shown that the duration of computer use of more than four hours a day is a risk factor for CVS [14]. Using the computer for a long time and continuously will cause problems with the ability to focus the eyes on the screen [17]. In addition, when computer users are focused on looking at the screen, it will usually make the blinking decrease so that the tears do not spread properly to moisten the eyes [13]. The use of eye drops when using a computer can be recommended to help moisturize the eyes so that there is no dryness in the eyes due to reduced blinking frequency. In addition, taking short breaks can also help reduce the chances of eye strain and keep your eyes focused while using the computer. The best-resting technique to be applied when using a computer is a break with the 20-20-20 technique, that is, after using the computer for 20 minutes, look at objects as far as 20 feet for 20 seconds.

Overall, CVS symptoms can include eye complaints and musculoskeletal complaints. The symptoms that are felt may not be severe and do not bother some people, but the next impact that occurs if CVS is not overcome is the existence of obstacles in daily activities such as decreased work productivity, increased error rates in work or study, and decreased job satisfaction [29]. To avoid this, it can be implemented through preventive measures. Among others, by using glasses or contact lenses that are given

anti-reflective (AR) coating for those who have refractive errors, using moisturizing eye drops to reduce eye irritation, and resting the eyes periodically. In addition, the computer user can use an anti-glare filter on the VDT monitor, adjust the distance of the monitor to the eyes as far as 35-40 inches, set the monitor in a position 15% lower than the horizontal field of the eye to prevent musculoskeletal complaints, maintain a good sitting position during doing activities in front of the computer, adjusting the light intensity, contrast, and brightness of the monitor, and setting the workspace lighting to no more than three times the average monitor lighting [30].

3.3. Advantages and limitations of the study

This study had several advantages compared to similar previous studies, which included ergonomic knowledge variables and emotional exhaustion in students, where these variables were rarely used as variables studied related to CVS in Indonesia. In terms of methodology, the cross-sectional design used in this study was significant because it was the most feasible design to use, considering the unavailability of data on CVS in health institutions. Another advantage of this research was that it indirectly describes the impact of the COVID-19 pandemic, namely the risk of increasing CVS events in students.

However, this research could not be separated from the existence of several weaknesses. The first was that data collection was not done by direct measurement but by using an instrument in the form of a questionnaire distributed online. This had to be carried out considering the ongoing COVID-19 pandemic conditions and the restrictions on community activities that were still being implemented. From the data collected through the online questionnaire, the answers given by respondents could contain information bias from variables that ideally require direct measurements, such as room lighting and eye distance from the monitor screen. In addition, this study focused on the use of computers and laptops only, excluding other devices such as smartphones, televisions, and others as devices that could be considered related to CVS events. Thus, the generalization of the results of this study can only be carried out on populations with similar characteristics using similar devices.

4. CONCLUSION

The conclusion obtained from this study was that emotional exhaustion and duration of computer use were important risk factors for CVS in students during online learning. Therefore, it was necessary to increase socialization regarding the ergonomics of using computers and stress management to students to prevent CVS in students.

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BIOGRAPHIES OF AUTHORS

Reva Maya Tika is a graduate of the Bachelor of Environmental Health Program, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia. She started studying in the Bachelor of Environmental Health Program, Faculty of Public Health, Universitas Indonesia in 2017 and graduated in 2022. She can be contacted at email: reva.maya@ui.ac.id.

Laila Fitria is a Lecturer in the Department of Environmental Health, Faculty of Public Health Universitas Indonesia, Depok, Indonesia. Doctoral degree in Epidemiology at the Universitas Indonesia. Most of her research is in the field of environmental health and occupational health epidemiology. Author of several international peer reviewed publications about environmental health, occupational health, and public health. She can be contacted at email: lfitria@ui.ac.id.