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Analysis of Risk Factors in Computer Vision Syndrome: A Case Control Study

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ABSTRACT

The use of computer for a long time period can cause a ocular complaints called Computer Vision Syndrome (CVS). This syndrome can be influenced by various risk factors, such as individual factors, computer factors and environmental factor. This study is to identify and analyze individual, computer and environmental factors associated with the incidence of Computer Vision Syndrome (CVS). This research is an observational study with a case control method. The study was conducted in September-October 2018 at General hospital Haji Surabaya. A sample of 266 people with certain criteria, divided into 2 groups of cases and controls. The research was conducted by direct interview using a questionnaire. The statistical test uses the Chi square test. The odds ratio used to determine the value of the association of the magnitude of the risk and multivariate analysis (logistic regression analysis) is used to find out which risk factor is the most influential. The 95% confidence interval and the results of the case-control study observations are arranged in a 2x2 table. The factors that were significantly associated with the incidence of CVS were gender [p = 0.009; odd ratio = 0.504 (95% CI = 0.301 – 0.843)], use of glasses [p = 0.000; odds ratio = 0.333 (95% CI = 0.201 – 0.553)], duration of working hours on the computer [p = 0.000; odds ratio = 0.331 (95% CI = 0.194 – 0.563)] and computer vision distance [p = 0.000; odds ratio = 0.331 (95% CI = 0.194 – 0.563)].

Keywords: individual factors; computer factors; environmental factors; computer vision syndrome.

INTRODUCTION

In the current era of technology, the use of computers has increased rapidly, both in offices and outside offices. Almost every human activity cannot be separated from the use of computers. The role of computers along with the increasingly popular use of the internet has caused everyone to spend a long time in front of computers and other digital media [1,2].

Although there are many benefits that can be obtained from using a computer, not many people realize that working in front of a computer for a long time and continuously can cause its own ocular problems [3]. In research in the United States, more than 143 million people work using computers every day, 90% of them suffer from eye fatigue. Bausch and Lomb report that nearly 60 million people suffer from eye or vision problems due to computer work and one million new cases are reported annually [1].

Problems with the eyes and vision associated with computer use are called Computer Vision Syndrome (CVS). Symptoms that arise include symptoms of asthenopia (eye strain, eye pain, dry eyes, and headache), symptoms related to the ocular surface (watering eyes, irritated eyes, and contact lens wear), visual symptoms (blurred vision, double vision, presbyopia, and difficulty focusing vision), and extraocular symptoms (shoulder pain, neck pain, and back pain) [4,5,6]

Computer Vision Syndrome (CVS) can be influenced by various factors, namely individual factors, environmental factors, and computer factors. Individual factors that play a role in the occurrence of CVS include age, gender, use of contact lenses, use of glasses, duration of working with computers, duration of working on the computer and long rest after using the computer. Environmental factors that play a role include the source of room lighting, room humidity and room air temperature. While the factors that come from the computer include the viewing distance, the position of the top of the monitor to the horizontal height of the eye, the polarity of the monitor and the type of computer [7,8].

A survey conducted by the American Optometric Association (AOA) in 2004 proved that 61% of Americans experience very serious eye problems due to working with computers for a long time. AOA and the Federal Occupational Safety and Health Administration believe that CVS in the future will be a major complaint for workers [6].

CVS is not a life-threatening syndrome. Clinical manifestations of this syndrome may not be severe and not bothersome for some people. This triggers the public's ignorance in checking their health so that this syndrome does not get the right treatment. The consequences that can occur if this syndrome is not overcome are obstacles in daily activities, a decrease in one's work productivity, an increase in the error rate at work, and a decrease in job satisfaction. These impacts are certainly detrimental because they can reduce a person's quality of life [7]

The increasing use of computers in everyday life will increase the incidence of CVS, especially if the existing risk factors are not detected and prevented early. This makes CVS special attention to the world of occupational medicine so that many studies have been carried out abroad.

Many studies on CVS have been carried out but not many have examined the 3 factors. especially related to all influencing factors, namely individual, computer and environmental factors. Therefore, researchers want to conduct research to determine the relationship between these three factors with the incidence of Computer Vision Syndrome (CVS).

RESEARCH METODOLOGY

The research was carried out at General Hospital Haji Surabaya, in September-October 2018. This study used a case control design. Case control is used because this method compares the risk factors that affect the case group (subjects with effects) with the control group (subjects without effects).

The study started by identifying the case group and looking for the control group. The determination of the case group and control group was carried out based on direct interviews with questionnaires. Computer user workers who complained of at least three main symptoms of CVS from direct interviews were included in the case group. Computer user workers who did not complain of symptoms at all until they complained of less than three main symptoms of CVS were included in the control group. The risk factors studied were traced in both groups, then compared. The type of data used in this research is primary data.

The target population in this study were computer users at general hospital Haji Surabaya. The research sample was taken by purposive sampling with inclusion criteria such as have worked with computers for at least 6 months and worked in front of computers for at least 1 hour continuously in a day. There are also exclusion criteria in this study: suffering from certain diseases (diabetes mellitus, hypertension, Sjogren's syndrome, Meibomian gland dysfunction, allergic conjunctivitis, vitamin A deficiency, thyroid disease, arthritis and trigeminal nerve or facial nerve injury) and currently undergoing certain medications [(diuretics, antihistamines, psychotropics (stimulant), antihypertensives, antidepressants, antibiotics, hormone replacement therapy, and steroids)]. Information about certain medications and certain diseases that are being undertaken is obtained through direct interviews.

There are 2 research variables, namely the independent variable and the dependent variable. The independent variables in this study were age, gender, use of glasses, duration of time working with a computer, duration of working in front of a computer, duration of rest after using a computer, viewing distance of the position of the top of the monitor to the horizontal height of the eye, type of computer, humidity of the room, temperature room and lighting. The dependent variable in this study is the incidence of Computer Vision Syndrome.

Data obtained from direct interviews using questionnaires. The data were processed and analyzed by computer using the SPSS program. The analysis was carried out descriptively and analytically. Descriptive analysis is presented in the form of graphs and tables. Analytical analysis to determine the relationship between the independent variable and the dependent variable used the Chi square test. The odds ratio was used to determine the value of the association of the magnitude of the risk used, and multivariate analysis (logistic regression analysis) was used to determine which risk factors were the most influential. The confidence interval is 95% and the results of the case control study are arranged in a 2x2 table.

RESULTS

The research data collection was carried out in September - October 2018. The data obtained were primary data obtained through direct interviews with respondents. Data obtained from respondents who are computer user employees at Haji General Hospital Surabaya as many as 277 respondents. Respondents who were excluded were 11 people with details of 5 respondents suffering from diabetes, 5 respondents suffering from hypertension and 1 respondent suffering from diabetes and hypertension. The number of respondents who met the inclusion criteria were 266 people.

Univariate analysis

Respondents in this study amounted to 266 people with 155 people in the case group and 111 people in the control group. Respondents are hospital employees who use computers in work units at Haji Hospital Surabaya.

• *The Incident of Computer Vision Syndrome*

The results of this study reported that the most common complaints experienced by respondents were eye strain (73.3%), even respondents from the case group almost all complained about this. The least complained symptom was double vision (28.1%).

Most of the respondents in this study were less than 40 years old (62.8%). Respondents aged less than 40 years in the case and control groups were 96 people (61.9%) and 71 (64%). Respondents who were more than 40 years old were 99 people (37%) namely 59 (38.1%) for the case group and 40 (36%) for the control group.

TABLE 1: Distribution of respondents according to CVS complaints

Complaints	CVS				total	%
	Cases		Control			
	n	%	n	%		
Eyestrain	150	96,8	45	40,5	195	73,3
dry eyes	93	60	9	8,1	102	38,3
Blurry vision	133	85,8	20	18	153	57,5
Headache	89	57,4	15	13,5	104	39,1
Eye pain	89	57,4	1	0,9	90	33,8
Epiphora	86	55,5	7	6,3	93	35
Diplopia	69	44,5	3	2,7	72	27,1
unfocused	103	66,5	7	6,3	110	41,4

The respondents of this study were 175 people (65.8%) were women with 112 of them (72.3%) were the case group. While the male respondents were 91 (34.2%), 43 of them (27.1%) were the case group.

• *Age*

TABLE 2: Distribution of respondents by age

Age	CVS				total	%
	Cases		Control			
	n	%	n	%		
<40 years	96	61,9	71	64	167	62,8
≥ 40 years	59	38,1	40	36	99	37,2
Total	155	100	111	100	266	100

Most of the respondents in this study were less than 40 years old as many as 167 people (62.8%), with details of the case group 96 people (61.9%) and the control group 71 (64%). At the age of less than 40 years, the incidence of CVS was more in the case group and control group than in the age > 40 years.

• *Gender*

TABLE 3: Distribution of respondents by gender

Age	CVS				total	%
	Cases		Control			
	n	%	n	%		
Men	43	27,7	48	43,2	91	34,2
Women	112	72,3	63	56,8	175	65,8
Total	155	100	111	100	266	100

Most of the research respondents were female, as many as 175 people (65.8%) with 112 of them (72.3%) being the case group. This caused a big difference in the case group because the male respondents in that group only amounted to 43 people (27.7%).

• *Use of Glasses*

TABLE 4: Distribution of respondents based on glasses users

Glasses Users	CVS				total	%
	Cases		Control			
	n	%	n	%		
No	59	38,1	72	64,9	131	49,2
Yes	96	61,9	39	35,1	135	50,8
Total	155	100	111	100	266	100

Respondents in this study were more using glasses, namely as many as 135 people (50.8%) compared to those who did not wear glasses, but the number between those who used glasses and those who did not use glasses was not too much different.

• *Duration of working with computer*

TABLE 5: Distribution of respondents based on duration of time working with computers

Duration of working with the computer	CVS				total	%
	Cases		Control			
	n	%	n	%		
<5 years	34	21,9	17	15,3	51	19,2
≥5 years	121	78,1	94	84,7	215	80,8
Total	155	100	111	100	266	100

Most of the respondents in this study were those who had worked with computers for more than 5 years, as many as 215 people (80.8%) and most of them were case groups, namely 121 people (78.1%) and some were included in the control group as many as 94. people (84.7%). While the respondents who worked less than 5 years were 51 people (19.2%) of which some were included in the case group as many as 34 people (21.9%) and some were included in the control group as many as 17 people (15.3%).

• *Duration of working in front of computer*

TABLE 6: Distribution of respondents based on the duration of time working in front of the computer

Duration of working in front of computer	CVS				total	%
	Cases		Control			
	n	%	n	%		
<4 hours	34	21,9	51	45,9	85	32
≥4 hours	121	78,1	60	54,1	181	68
Total	155	100	111	100	266	100

Respondents in this study mostly worked in front of the computer more than or equal to 4 hours continuously as many as 181 people (68%).

Where for the case group respondents worked more in front of the computer more than or equal to 4 hours continuously as many as 121 people (78.9%) than those who worked in front of the computer less than 4 hours as many as 34 people (21.9%). Meanwhile, for the control group, there was no significant difference between those who worked in front of the computer for less than 4 hours and those who worked in front of the computer for less than 4 hours and those that were greater than or equal to 4 hours continuously.

• *Duration of rest after using computer*

TABLE 7: Distribution of respondents based on the duration of rest after using computer

Duration of rest after using computer	CVS				total	%
	Cases		Control			
	n	%	n	%		
<10 minutes	58	37,4	47	42,3	105	39,5
≥10 minutes	97	62,6	64	57,7	161	60,5
Total	155	100	111	100	266	100

Respondents who took a break of more than or equal to 10 minutes after using the computer were 161 people (60.5%) more than those who rested for less than 10 minutes. Respondents who rested more than or equal to 10 minutes after using the computer were more in the case group than those in the control group.

• *Viewing distance*

TABLE 8: Distribution of respondents based on viewing distance

Viewing distance	CVS				total	%
	Cases		Control			
	n	%	n	%		
<50 cm	74	47,7	28	25,2	102	38,3
≥50 cm	81	52,3	83	74,8	164	61,7
Total	155	100	111	100	266	100

Respondents in this study more set the viewing distance more than or equal to 50 cm, namely as many as 164 people (61.7%), the difference was quite large with respondents who set the viewing distance as far as less than 50 cm.

• *Top of the monitor position at eye level*

TABLE 9: Distribution of respondents based on monitor position

Monitor position	CVS				total	%
	Cases		Control			
	n	%	n	%		
Higher	28	18,1	17	15,3	45	16,9
Parallel/ lower	127	81,9	94	84,7	221	83,1
Total	155	100	111	100	266	100

Most respondents (83.1%) have adjusted the position of the top of the monitor to be parallel/lower to the horizontal eye level and most of them belong to the case group of 127 people (81.9%).

• *Computer Type*

TABLE 10: Distribution of respondents by type of computer

Computer Type	CVS				total	%
	Cases		Control			
	n	%	n	%		
convex screen	2	1,31	0	0	2	0,8
flat screen	135	98,7	111	100	264	99,2
Total	155	100	111	100	266	100

Almost all of the computers used by respondents in this study used a flat screen type, as many as 264 people (99.2%). Most of the respondents in this group were included in the case group as many as 153 people (98.7%) and the group of respondents who used a convex screen computer or a tube without an antiglare filter were all included in the case group.

• *Humidity*

TABLE 11: Distribution of respondents based on air humidity

Humidity	CVS				total	%
	Cases		Control			
	n	%	n	%		
<40%	0	0	0	0	0	0
40-60%	78	50,3	64	57,7	142	53,4
≥ 60%	77	49,7	47	42,3	124	46,6
Total	155	100	111	100	266	100

The humidity in the working room of the respondents in this study mostly showed between 40 and 60 as many as 142 people (53.4%) and there was no significant difference in the number of respondents who entered the case group and the control group.

• *Room lighting*

TABLE 12: Distribution of respondents based on room lighting

Room Lighting	CVS				total	%
	Cases		Control			
	n	%	n	%		
<300 lux	138	89	101	91	239	89,8
300-500 lux	10	6,5	10	9	20	7,5
≥ 500 lux	7	4,5	0	0	7	2,6
Total	155	100	111	100	266	100

The lighting used in the respondent's workspace mostly uses lighting less than 300 lux meters as many as 239 people (89.8%) of which 138 people are in the case group and 101 people are in the control group.

• *Room temperature*

TABLE 13: Distribution of respondents based on room temperature

Room temperature	CVS				total	%
	Cases		Control			
	n	%	n	%		
<23°	0	0	0	0	0	0
23-36°	93	60	74	66,7	167	62,8
≥26°	62	40	37	33,3	99	37,2
Total	155	100	111	100	266	100

The room temperature used in the respondent's work room mostly used temperatures between 23° to 26° as many as 167 people (62.8%), where there was no significant difference between those in the case group and those in the control group.

Bivariate Analysis

• *The relationship between age and the incidence of CVS*

TABLE 14: The relationship between age and the incidence of CVS

Age	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
<40 years	96	61,9	71	64	0,917 (0,553-1,519)	0,736
≥40 years	59	38,1	40	36		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between age and CVS incidence obtained a value of p = 0,736 with an odds ratio of 0,917 (95% CI = 0,553 – 1,519). This shows that age has no significant relationship with the incidence of CVS.

• *The relationship between gender and the incidence of CVS*

TABLE 15: The relationship between gender and the incidence of CVS

Gender	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
Men	43	27,7	48	43,2	0,504 (0,301 – 0,843)	0,009
Women	112	72,3	63	56,8		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between gender and CVS incidence obtained a value of p = 0,009 with an odds ratio of 0,504 (95% CI = 0,301 – 0,843). This shows that the sex of computer users has a significant relationship with the incidence of CVS, where male computer user workers are at one time less risk of suffering from CVS than female computer users.

• *The relationship between the use of glasses with the incidence of CVS*

TABLE 16: The relationship between the use of glasses with the incidence of CVS

Glasses Users	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
No	59	38,1	72	64,9	0,333 (0,201 – 0,553)	0,000
yes	96	61,9	39	35,1		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between the use of glasses and the incidence of CVS obtained a value of p = 0,000 with an odds ratio of 0.333 (95% CI = 0,201 – 0,553). This shows that the use of glasses has a significant relationship with the incidence of CVS, where computer workers who do not use glasses are three times less likely to suffer from CVS than computer workers who use glasses.

• *The relationship between duration of time working with a computer and the incidence of CVS*

TABLE 17: The relationship between duration of time working with a computer and the incidence of CVS

Duration of working with the computer	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
<5 years	34	21,9	17	15,3	1,554 (0,818 – 2,951)	0,176
≥5 years	121	78,1	94	84,7		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between duration of time working with a computer and the incidence of CVS obtained a value of p = 0.176 with an odds ratio of 1.554 (95% CI = 0.818 – 2.951). This shows that the duration of time working with the computer has no significant relationship with the incidence of CVS.

- *The relationship between duration of working in front of a computer and CVS*

TABLE 18: The relationship between duration of working (hours) in front of a computer with the incidence of CVS

Duration of working in front of computer	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
<4 hours	34	21,9	51	45,9	0,331 (0,194-0,563)	0,000
≥4 hours	121	78,1	60	54,1		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between duration of time working in front of a computer and the incidence of CVS obtained a value of p = 0.000 with an odds ratio of 0.331 (95% CI = 0.194 – 0.563). This shows that duration of working hours in front of a computer have a significant relationship with the incidence of CVS, where workers who work less than 4 hours in front of a computer are three times less likely to suffer from CVS than workers who work in front of a computer for more than or equal to 4 hours.

- *The relationship between duration of rest after computer use with the incidence of CVS*

TABLE 19: The relationship between the duration of rest after computer use with the incidence of CVS

Duration of rest after using computer	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
<10 minutes	58	37,4	47	42,3	0,814 (0,495-1,339)	0,418
≥10 minutes	97	62,6	64	57,7		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between duration of rest and the incidence of CVS obtained a value of p = 0.418 with an odds ratio of 0.814 (95% CI = 0.495 – 1.339). This shows that the duration of rest has no significant relationship with the incidence of CVS.

- *The relationship between viewing distance and the incidence of CVS*

TABLE 20: The relationship between viewing distance and the incidence of CVS

Viewing distance	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
<50 cm	74	47,7	28	25,2	2,708 (1,591-4,609)	0,000
≥50 cm	81	52,3	83	74,8		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between visual distance and CVS events obtained a value of p= 0.000 with an odds ratio of 2.708 (95% CI = 1.591 - 4.609). This shows that the viewing distance of workers with computers has a significant relationship with the incidence of CVS, where the viewing distance of workers with computers that is less than 50 cm has twice the risk of suffering from CVS compared to workers who use distance vision with computers of more than or equal to 50 cm.

- *The relationship between the position of the top of the monitor to the horizontal level of the eye with the incidence of CVS*

TABLE 21: The relationship between the position of the top of the monitor to the horizontal eye level with the incidence of CVS

Monitor position	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
Higher	28	18,1	17	15,3	1,219 (0,631-2,356)	0,555
Parallel/ lower	127	81,9	94	84,7		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between the position of the top of the monitor to the horizontal height of the eye with the incidence of CVS obtained a value of p = 0.555 with an odds ratio of 1.219 (95% CI = 0.631 – 2.356). This shows that the position of the top of the monitor to the horizontal height of the eye has no significant relationship with the incidence of CVS.

- *The relationship between the type of computer with the incidence of CVS*

TABLE 22: The relationship between the type of computer and the incidence of CVS

Computer type	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
convex screen	2	1,31	0	0	1,725 (1,557-1,912)	0,230
flat screen	135	98,7	111	100		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between the type of computer used by workers and the incidence of CVS obtained a value of p = 0.230 with an odds ratio of 1.725 (95% CI = 1.557 - 1.912). This shows that the type of computer used by workers has no significant relationship with the incidence of CVS.

- *The relationship between humidity and the incidence of CVS*

TABLE 23: The relationship between humidity and the incidence of CVS

Humidity	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
<40%	0	0	0	0	0,744 (0,455-1,215)	0,237
40-60%	78	50,3	64	57,7		
≥ 60%	77	49,7	47	42,3		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between air humidity in the workers' workspace and the incidence of CVS obtained a value of p = 0.237 with an odds ratio of 0.744 (95% CI = 0.455 – 1.215). This shows that the humidity in the workers' workspace has no significant relationship with the incidence of CVS.

• *The relationship between room lighting and CVS*

TABLE 24: The relationship between room lighting and the incidence of CVS

Room Lighting	CVS				OR (95%CI)	p
	Cases		Control			
	n	%	n	%		
<300 lux	138	89	101	91	-	0,061
300-500 lux	10	6,5	10	9		
≥ 500 lux	7	4,5	0	0		
Total	155	100	111	100		

The results of the bivariate analysis regarding the relationship between lighting in the workers' workspace and the incidence of CVS obtained p value = 0.061. This shows that the lighting in the workers' workspace has no significant relationship with the incidence of CVS.

• *The relationship between air temperature and the incidence of CVS*

TABLE 25: The relationship between air temperature and the incidence of CVS

Room temperature	CVS				total	%
	Cases		Control			
	n	%	n	%		
<23°	0	0	0	0	0	0
23-36°	93	60	74	66,7	167	62,8
≥26°	62	40	37	33,3	99	37,2
Total	155	100	111	100	266	100

The results of the bivariate analysis regarding the relationship between the air temperature in the workers' workspace and the incidence of CVS obtained p value = 0.267 with an odds ratio of 0.750 (95% CI = 0.451 - 1.248). This shows that the air temperature in the worker's workspace has no significant relationship with the incidence of CVS.

Multivariate analysis

Previous bivariate analysis has analyzed any risk factors that are associated or not significantly associated with the incidence of CVS. Factors that were significantly related and that were not significantly related but had a p-value of less than 0.25, such as: gender, use of glasses, duration of working hours at the computer, duration of rest after computer use, viewing distance, and subsequent types of computers. multivariate analysis with logistic regression to determine the risk factors that most influence the incidence of CVS.

TABLE 26: Results of multivariate analysis with logistic regression

Variable	Exp (B)	95% CI	Sig.
Gender	0,531	0,304 – 0,925	0,026
Age	1,047	0,595 – 1,843	0,874
Duration of working	2,301	1,118 – 4,737	0,024
Duration of focus	0,304	0,169 – 0,548	0,000
Duration of rest	1,144	0,660 – 1,985	0,631
Glasses	0,376	0,217 – 0,651	0,000
Type of computer	6,137E8	0,000	0,999
Viewing distance	3,046	1,654 – 5,608	0,000
Monitor position	0,915	0,432 – 1,938	0,817

Factors that have a significant effect after multivariate analysis, namely viewing distance to computer, duration of work using a computer and duration of rest after using a computer. The viewing distance to computer is three times riskier when its less than 50 cm, compared to the viewing distance that more than or equal to 50 cm. duration of time working using a computer for more than or equal to 5 years has a double risk to suffer from CVS compared to those who have worked on a computer for less than five years. Rest periods of less than 10 minutes are at risk of one time compared to rest periods of more than 10 minutes.

DISCUSSION

Risk factors associated with CVS

• *Gender*

Women are more at risk than men to suffer from CVS. The results of this study found that the gender of computer users significantly associated with the incidence of CVS, that men are at one-time risk less likely to suffer from CVS than women. These results support previous studies that reported a higher CVS incidence in women [7,8,9,10]. However, different results were obtained in other studies, namely not there is a significant difference between men and women in the incidence of CVS [8,11,12].

Several theories that support the results of this study include that women are more prone to eye fatigue than men, because there is a greater decrease in accommodation in women compared to men, which can weaken the eye focusing images on the retina [13]. There are physiological differences between women and men can also make women more susceptible to disease and women's stress levels are higher than men that are not related to work, such as taking care of children and housework [1,14].

Several factors in this study can also have an effect on these significant results. The frequency of respondents in this study is indeed more female than male. Women tend to be more thorough and painstaking in their work so that they will really focus on the work at hand to reduce the rate of work errors. The majority of respondents in their job is to enter data in the form of numbers into the computer. This requires concentration and accuracy. The demand to be able to concentrate in front of the computer continuously can be a source of stress for vision and psychology and eventually lead to visual complaints.

• *Use of glasses*

The results of the bivariate analysis showed a significant relationship between the use of glasses and non-glasses users on the incidence of CVS. These results are in accordance with the research of Edema et al. who reported a significant difference between VDT users who wore glasses and VDT users who did not wear glasses in the incidence of asthenopia [15]. Reddy SC also found a significantly higher incidence of CVS in students who wore glasses compared to those who did not wear glasses [16].

Correction of refractive errors and proper wearing of eyeglasses is a powerful factor in relieving asthenopia symptoms. With a minimum viewing distance of 50 cm in front of the computer, glasses of different sizes are needed for work, namely a combination of the need for close reading and intermediate distance reading. Computer glasses with progressive lenses are designed for optimal vision at reading distances and intermediate distances, thereby reducing the complaints of presbyopic computer users.

• *Duration of working in front of the computer*
In this study, it was found that workers who worked less than 4 hours in front of a computer were three times less likely to suffer from CVS than workers who worked in front of a computer for more than or equal to 4 hours.

Increasing working hours in front of the computer without being interspersed with other activities can reduce the ability to accommodate so that it will exacerbate CVS symptoms in computer user workers. [5,17] Long time working in front of the computer can also trigger the problem of changing focus on the screen, documents and keyboard. The process of searching and refocusing on the text on the screen continuously can cause eye fatigue and pain [16]

A study by Ye Z et al on the relationship between VDT use on physical and mental state of administrative employees in Japan reported that there was a significant difference in the incidence of eye strain among non-VDT users, VDT users who worked less than five hours a day, and VDT users who worked more. of equal to five hours a day [18]. Study by Edema et al. found that 53.15% of respondents used computers continuously for four hours causing them to be more at risk of experiencing stress due to computer use [15]. In another study showed that the prevalence of visual symptoms was higher in that spend more than 4 hours on VDT [19] Different results were obtained in the study by Assefa et al, namely there was no significant difference in the occurrence of CVS between working in front of the computer less than or equal to 6 hours by working in front of the computer more than 6 hours[12].

• *Viewing distance*
The results of the analysis of the relationship between distance vision and the incidence of CVS show that these two things are related. The recommendation viewing distance is between 30 cm and 70 cm [20] in other study in Nigeria found that visual complaints in respondents who employed less than 10cm viewing distance are more pronounced than the respondents who employed 20-30cm viewing distance [21] The results of this study are in accordance with previous studies too, who reported that complaints of visual disturbances were more common in workers with a vision distance of less than 10 inches (25.4 cm) [22] A study by Logaraj et al found that students who saw at a distance of less than 50 cm were at greater risk of CVS, one of the CVS complaints, namely blurred vision, were found to increase significantly [12]. Distance to the computer is also an important risk factor for eye complaints. The closer the computer screen is to the eyes, the eyes work harder to accommodate. This will cause tired eyes and headaches. Taptagaporn et al. recommends that the viewing distance is 50-70 cm and another opinion states that the farther the monitor is placed (90-100 cm) the less visual complaints occur [23].

Risk factors not associated with CVS

• *Age*
In this study, there was no significant difference between the age group of less than 40 years and the age group of more than or equal to 40 years. these results are in accordance with previous studies [12,24] Respondents in this study were mostly less than 40 years old (62.8%) and it is possible that the high incidence of CVS in this age group. This result is different from the study by Das et al. which states that those over 40 years of age complain of discomfort due to computer use with the highest level compared to other age groups because it is related to the aging process (so that there are anatomical changes and decreased body functions) [25]

• *Duration of working with computer*
The results of the analysis of the relationship between length of time working with a computer show that length of time working with a computer is not associated with the incidence of CVS. Different results were obtained in previous studies by Bhanderi et al. who reported that the incidence of CVS was higher in VDT users who worked with computers for more than five years[26] Another study reported that the incidence of CVS was higher among computer users who had worked for more than 7 years [27] and 10 years[5]

• *Duration of rest after using the computer*
This study found that resting less than 10 minutes after using the computer was no different from resting for more than or equal to 10 minutes after using the computer for CVS events. This study supports the results of previous studies by Reddy CS et al [16]. Research by Noreen et al. found that there was no significant relationship between CVS symptoms and resting frequency [28]. To preventing eyestrain, eyes should be rest for 15 minutes after 2 hours computer use [19].Different results were obtained in the study by Ye Z et al. which states that resting for 10-15 minutes after using a computer is a protective factor against the emergence of CVS complaints, while not taking time to rest is a risk factor with an odds ratio of 5,1.[3]. In an Ethiopia study showed that those who work in front of computer more than 20 minutes without a rest is 2 times more likely at risk to suffer CVS [29]

• *Top position of the monitor at eye level*
The results of the analysis showed that the position of the top of the monitor to the horizontal height of the eye was not associated with the incidence of CVS.

The results of this study are not in accordance with the theory which states that the position of the top of the monitor can be a factor that causes complaints due to computer use[17] In another showed that a respondents that viewed the computer screen below the level of eyes were less likely to develop CVS [27] .It is possible that the majority of respondents have positioned the top of the monitor at or below the horizontal level of the eye. This indicates that the respondent already knows a good position between the monitor and the eye which can minimize the incidence of ocular complaints.

• *Computer type*
Almost all of the respondents used a flat screen, as many as 264 people (99.2%). The type of computer between a flat screen (LCD) and a convex screen (CRT) has no relationship with the incidence of CVS. A previous study compared various lighting as the background and found that there was no significant relationship between CRT monitors and LCD monitors on asthenopia symptoms between monitors with asthenopia symptoms [5] The results of this study are different from the study by Amira which found that tube computer users who did not use antiglare filters had four risks. half times more likely to experience CVS than workers using tube-type computers with antiglare screens or computers with flat screens [7]

• *Room lighting*
In theory, improper lighting conditions in the workspace can have an adverse effect on the comfort of the eyes of computer users, although it does not cause chronic visual impairment, but can be annoying and allow eyes to become tired [5]

The results of this study found that the lighting in the respondent's workspace was not significantly related to the incidence of CVS. This is similar to the results of research by Wisnu E.S [30]. Most of the respondents in this study were less than 40 years old, so they did not really need very bright light when working in front of the computer. Another possibility is that the lighting in the respondent's room has not exceeded 3 times the lighting on the computer screen because if it exceeds it will cause glare and reflections on the screen that interfere with the view.

Research conducted by Reddy S.C et al. on student computer users by using fluorescent room lights and natural sunlight, the results obtained are not significant between the 2 light sources on CVS complaints [16]

• *Room air temperature*

The working room air temperature has no significant relationship with the incidence of CVS. This can happen because most of the respondents are in the work room with the appropriate temperature required for health and comfort. Only a third of the respondents were in a room with a high temperature. In theory, a high room air temperature can reduce the frequency of blinking [14] If the frequency is decreased it can cause dry eyes due to evaporation. Dry eyes cause people to tend to tilt their heads in an attempt to see better and cause headaches [31]

• *Air humidity*

Based on the Minister of Health Number 48 of 2016, to get the level of comfort in the office space required moisture content with a humidity level of 40-60%. In this study, air humidity had no significant relationship with the incidence of CVS. More than half of the respondents in this study were in a room with the recommended humidity.

CONCLUSION

Type, duration of time working in front of the computer, use of glasses and viewing distance are associated with CVS incidence. Male computer workers are one times less likely to suffer from CVS than female computer workers, working in front of a computer for less than 4 hours are three times less likely to suffer from CVS than working in front of a computer more or equal to 4 hours continuously.

Workers who use glasses is three times more at risk than workers who doesn't wear glasses when using computers to developing CVS. With a viewing distance that less than 50 cm are twice less risk of developing CVS compared to those with a viewing distance of more than 50 cm.

Several factors that were not related to the incidence of CVS included age, duration of work with the computer, duration of rest, position of the top of the monitor to the horizontal level of the eye, type of computer, humidity, room lighting and room temperature.

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