Jurnal Saintika Medika
Jurnal Ilmu Kesehatan dan Kedokteran Keluarga
Faculty of Medicine UMM

Vol. 19 No. 1 June 2023
p-ISSN : 0216-759X e-ISSN : 2614-X476X
http://ejournal.umm.ac.id/index.php/sainmed

The Relationship between Screen Time and Screen Size with Computer Vision Syndrome

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Receive : Jan 9th2023. Revised : Apr 1th2023. Published : Jun 30th 2023

DOI : https://doi.org/10.22219/sm.Vol19.SMUMM1.22564

ABSTRACT

During the COVID-19 pandemic, student activities are conducted online using various sizes of gadgets. This situation increases the risk of computer vision syndrome (CVS), a group of eyes and vision problems that occur when using digital devices excessively. The risk of CVS increases when using small-sized gadgets. This study aims to determine the relationship between screen time and screen size with CVS among Universitas Pembangunan Nasional "Veteran" Jakarta medical students. The study used a cross-sectional design, questionnaire, and application to measure screen time. The study showed that 59.5% of the 84 subjects experienced CVS symptoms. The screen time of subjects on smartphones was 7.22 ± 3.01 hours/day and 6.03 ± 3.49 hours/day on laptops. The subject uses a 14 (11 - 16)- inch laptop and a 6.4 (4.7 – 6.7)- inch smartphone. The Pearson correlation test showed a correlation between screen time and CVS scores ($p = 0.032$; $r = 0.234$). The Chi-square test showed there were differences in symptoms of excessive blinking between the group with laptops ≤ 14 inches and > 14 inches ($p = 0.019$), as well as differences in symptoms of red eyes ($p = 0.042$) and blurred vision ($p = 0.031$) between the group with smartphones < 5.8 inches and ≥ 5.8 inches. There is a relationship between screen time and screen size with CVS.

Keywords: Computer Vision Syndrome, Laptop, Screen Time, Screen Size, Smartphone

INTRODUCTION

Major changes in education have occurred in Indonesia, one of which is the implementation of online learning based on Circular Letter Number 4 of the year 2020 on the Implementation of Education Policies during the Emergency Period of the Spread of Corona Virus Disease (COVID-19) (Nafrin & Hudaidah, 2021). The students were using smartphones or laptops during online learning (Handarini & Wulandari, 2020) so that increased the gadget screen time (Qin et al., 2020).

The study results of Xiang et al. (2020) shows that screen time increased to 1.730 minutes/week or 30 hours/week during the COVID-19 pandemic. Another study shows that screen time during online learning increases to more than 6 hours/day (Ganne et al., 2021). Screen time can be measured using screen time tracking apps or applications that track the time spent staring at the screen so that the total screen time calculation is more accurate.

Increased screen time can cause a vision problem called computer vision syndrome (CVS) (Klamm & Tarnow, 2015; Ahmed et al., 2019). Computer vision syndrome is a group of eyes and vision problems caused by near vision activities when using digital devices excessively. Using gadgets for 2 hours increases the risk of CVS (AOA, 2017). Generally, CVS symptoms are temporary and disappear when one stops using digital devices. However, in some cases, the symptoms will cause a decrease in visual abilities, for example, blurred vision when looking at a distance and musculoskeletal problems (AOA, 2017). Several CVS symptoms identified were burning eyes, itchy eyes, foreign body sensation in the eyes, watery eyes, excessive blinking, red eyes, eye pain, heavy eyelids, dry eyes, double vision, blurred vision, difficulty to focus on nearby objects, increased light sensitivity, seeing colored halos around an object, worsening vision, and headaches (Seguí et al., 2015). In addition to screen time, a factor that increases the risk of CVS is the gadget size. The smaller the gadget size, the more frequent symptoms of eye strain and eye fatigue occur (Olatunde et al., 2013; Wu et al., 2016).

Another study shows that medical students use soft copies or e-books more often than textbooks, thus increasing screen time (Kharel Sitaula & Khatri, 2018). The CVS prevalence among medical students is relatively high, 71.6% in Nepal, 94.8% in Pakistan, and 89.9% in Malaysia. In Indonesia, the CVS prevalence was 85.6% among medical students of Universitas Sumatera Utara and 58.8% among medical students of Universitas Udayana (Harahap, 2020; Kharel Sitaula & Khatri, 2018; Vikanaswari & Handayani, 2018).

During the COVID-19 pandemic, students of the Faculty of Medicine, Universitas Pembangunan Nasional "Veteran" Jakarta (FMUPNVJ) carried out hybrid lectures and online non-academic activities. In online activities, students use various sizes of gadgets. This study aims to describe screen time, screen size, and the relationship between screen time and the size of the gadget with CVS of FMUPNVJ students.

METHODS

The study was conducted from February – June 2022 using a cross-sectional design. The study used a questionnaire to obtain subjects' demographic and behavior when using gadgets, a CVS-questionnaire (CVS-Q), and applications to measure screen time, namely YourHour Application (smartphone) and DeskTime Application (laptop). Behavioral questionnaires and CVS-Q have been tested on 30 medical students. The questionnaires are valid and reliable with Cronbach's Alpha each for behavior with a Guttman scale = 0.743, behavior with a Likert scale = 0.837, CVS-Q intensity = 0.740, and CVS-Q frequency = 0.750.

The study population was active FMUPNVJ students with inclusion criteria: emmetropia or mild myopia, willing to be research subjects, and downloading a screen-time measuring application on their gadget. Students using contact lenses, eye drops, have eye disorders, have a history of Sjogren's syndrome and eye allergies, diabetes mellitus, and thyroid disorders, have a history of eye

surgery, or take antidepressant drugs, antihistamines, beta-blockers, corticosteroids, diuretics, or hormone replacements were excluded from the study.

The sample size was calculated using the formula of difference in two groups' proportion with α = 5%, β = 80%, P_1 = 0.71, and P_2 = 0.93, which were taken from the Putri & Mulyono, 2018 study. The result of the calculation is multiplied by two plus 10% to anticipate the possibility of dropping out. The calculation result is 82 students. In the study, 84 prospective subjects met the criteria, so all of them were included as research subjects (total sampling). The research was conducted online using a Google form after obtaining ethical approval Number: 34/II/2022/KEPK from the Health Research Ethics Committee of UPNVJ. Univariate analysis was carried out to get an overview of the research variables, followed by the Pearson correlation test and Chi-square test to test the hypothesis. Data were analyzed using SPSS software.

RESULTS AND DISCUSSION

Most (71.4%) of the research subjects were female aged 20 (17-23) years. In the study, it was found that 59.5% experienced CVS symptoms. The relatively high proportion of CVS is caused by the subject's risk behavior when using gadgets. In Table 1, it can be seen most of the subject's behavior when using gadgets, namely: 54.8% take a rest every 1 hour, 44.1% take a rest with a duration of <15 minutes, 64.3% use gadgets at a distance less than 40 cm, 60.7% do not use antiglare screen, 61.9% use dim gadget lighting, and 95.2% use gadgets before going to bed (Table 1). The results show that the risk of CVS can be reduced by implementing the 20-20-20 rule, namely, take a rest every 20 minutes by looking at distant objects (≥ 20 feet) for 20 seconds, take a rest for 15 minutes every 2 hours, using an antiglare screen, adequate lighting, implement 1-2-10 rules for gadgets distance, which is 1 foot from the smartphone, 2 feet from the computer, and 10 feet from the television (AOA, 2017; Alemayehu & Alemayehu, 2019).

Table 1. Gadget Usage Behaviour

No	Characteristics	Frequency (n)	Percentage (%)
1	Rest interval		
	No rest	27	32.1
	Every 30 minutes	11	13.1
	Every ≥1 hours	46	54.8
2	Rest duration		
	No rest	27	32.1
	<15 minutes	37	44.1
	>15 minutes	20	23.8
3	Gadgets distance		
	<40 cm (less than one arm)	54	64.3
	40-76 cm (about one arm)	30	35.7

4	Use antiglare screen		
	No	51	60.7
	Yes	33	39.3
5	Gadget lighting		
	Very dim	6	7.1
	Dim	52	61.9
	Bright	26	31
6	Use gadgets before going to bed		
	No	4	4.8
	Yes	80	95.2

In this study, the average screen time for smartphones was 7.22 ± 3.01 hours/day, laptops 6.03 ± 3.49 hours/day, and total screen time was 13.25 ± 4.33 hours/day. In line with the results of this study is an increase in screen time of 61.4% during the pandemic compared to before the pandemic. It is known that 64.8% of the increase in screen time is caused by online lectures and the use of gadgets as entertainment media (Khare et al., 2021). The average medical student's screen time is 6.01 hours/day (Cacodcar et al., 2021) and 7.3 hours/day among Universitas Atmajaya medical students (Jahja et al., 2021). The Pearson correlation test results showed a correlation between screen time and CVS scores ($p = 0.032$; $r = 0.234$). In other words, the longer the screen time, the more severe CVS.

Computer vision syndrome occurs when looking at a gadget screen composed of pixels with characteristics bright in the center and dark at the edges. The eyes need to maintain focus on the character on the gadget screen. The resting point of accommodation of the eye is at the point behind the screen or the dark point (dark focus). This situation will cause a delay in accommodation so that the object seen blurred, and efforts are needed to restore focus by contraction of the ciliary body. Over time, these efforts cause tired eyes (Alemayehu & Alemayehu, 2019).

When staring at a screen, the eyes tend to be misaligned so that the extraocular muscles are tense because it plays a role in realigning the eyes to avoid double vision. This effort causes overstimulation of the trigeminal nerve. The trigeminal nerve has three branches, the ophthalmic nerve, the maxillary nerve, and the mandibular nerve. Branches of the ophthalmic nerve innervate the eye and orbit, as well as most of the duramater. The caudal trigeminal nerve transmits information between the eyes and the central nervous system that extends to the cervical spine. Excessive stimulation of the trigeminal nerve will irritate, causing pain in some parts of the eyes, head, and neck (Labhishetty, 2021).

Another theory states that when attention is increased on the screen, there will be an increase in sympathetic stimulation, thereby decreasing the accommodative response. Parasympathetic stimulation to the ciliary muscle will increase to compensate for that mechanism. This condition causes misalignment of the eye, which stimulates the trigeminal nerve and causes symptoms of

headache, neck pain, and eye strain. The increased load on the ciliary muscles will also activate the trapezius muscles in the neck and shoulders, causing pain and tension in these areas. Posture during screen time also affects the incidence of CVS. The wrong posture will increase the risk of CVS (Labhishetty, 2021).

The subjects of this study used a laptop 14 (11 - 16) inches and a smartphone 6.4 (4.7 - 6.7) inches. A laptop size of 14 inches is a standard and ideal size that meets ergonomic criteria for laptop use (Yuswati & Isman, 2016). Research subjects use a smartphone with a commonly used size of 5.8 inches (Jahrami et al., 2021). The study results showed no differences in the demographic characteristics and behavior of using gadgets between the two groups which were compared based on the size of the smartphone and laptop ($p > 0.05$). Therefore, the analysis results that showed differences in CVS symptoms between the two groups (Tables 2 & 3) were concluded to be caused by differences in the size of smartphones and laptops.

It can be seen in Table 2 the distribution of CVS symptoms based on laptop size. The results of the Chi-square test showed differences in symptoms of excessive blinking between the two groups with laptop sizes ≤ 14 inches and > 14 inches ($p = 0.019$). The use of gadgets can reduce the blink reflex up to 66% or to 3-6 times per minute (Permana et al., 2015). This can cause tear film instability. Furthermore, tear film instability can result in dry eye disease (DED) which causes a hyperosmotic condition and an inflammatory response in the eye. As a result of DED, the thickness of the tear film is reduced, and the eye will blink excessively to prevent further tear loss. Excessive blinking will also stimulate the fifth and seventh cranial nerves which produce more tears (Akinbinu & Mashalla, 2014; Alemayehu & Alemayehu, 2019; Zhao et al., 2021).

It can be seen in Table 3 the distribution of CVS symptoms based on the smartphone size. The results of the Chi-square test showed that there were differences in symptoms of red eye ($p = 0.042$) and symptoms of blurred vision ($p = 0.031$) between the group with a smartphone < 5.8 inches and the smartphone ≥ 5.8 inches.

Table 2. Laptop Size and CVS Symptoms

No.	Laptop Size	No Symptoms		Mild + Moderate Symptoms		Severe Symptoms		Total		p-value
		N	%	N	%	n	%	N	%	
	Burning eyes									
1	< 14 inci	14	82.4	3	17.6	0	0	17	100	1.000
	≥ 14 inci	55	82.1	12	17.9	0	0	67	100	
	Itchy eyes									
2	< 14 inci	9	52.9	8	47.1	0	0	17	100	0.530
	≥ 14 inci	26	38.8	40	59.7	1	1.5	67	100	
3	Foreign body sensation									

	< 14 inci	9	52.9	8	47.1	0	0	17	100	0.237
	≥ 14 inci	48	71.6	19	28.4	0	0	67	100	
	Watery eyes									
4	< 14 inci	4	23.5	12	70.6	1	6.3	17	100	0.383
	≥ 14 inci	24	35.8	42	62.7	1	1.5	67	100	
	Excessive blinking									
5	< 14 inci	7	41.2	10	58.8	0	0	17	100	0.019
	≥ 14 inci	50	74.6	17	25.4	0	0	67	100	
	Red eyes									
6	< 14 inci	10	58.8	7	41.2	0	0	17	100	0.719
	≥ 14 inci	45	67.2	22	32.8	0	0	67	100	
	Eye pain									
7	< 14 inci	9	52.9	8	47.1	0	0	17	100	0.648
	≥ 14 inci	42	62.7	25	37.3	0	0	67	100	
	The sensation of heaviness in the eyes									
8	< 14 inci	7	41.2	10	58.8	0	0	17	100	0.287
	≥ 14 inci	42	62.7	24	35.8	1	1.5	67	100	
	Dry eyes									
9	< 14 inci	9	52.9	7	41.2	1	5.9	17	100	0.561
	≥ 14 inci	33	49.3	33	49.3	1	1.5	67	100	
	Blurred vision									
10	< 14 inci	10	58.8	7	41.2	0	0	17	100	0.744
	≥ 14 inci	33	49.3	32	47.8	2	3	67	100	
	Double vision									
11	< 14 inci	15	88.2	2	11.8	0	0	17	100	1.000
	≥ 14 inci	56	83.6	10	14.9	1	1.5	67	100	
	Difficulty focusing on nearby object									
12	< 14 inci	12	70.6	5	29.4	0	0	17	100	0.508
	≥ 14 inci	54	80.6	13	19.4	0	0	67	100	
	Increased light sensitivity									
13	< 14 inci	13	76.5	4	23.5	0	0	17	100	0.180
	≥ 14 inci	40	59.7	27	40.3	0	0	67	100	
	Colored halos around an object									
14	< 14 inci	14	82.4	3	17.6	0	0	17	100	0.143
	≥ 14 inci	63	94	4	6	0	0	67		
15	Worsening vision									
	< 14 inci	10	58.8	6	35.3	1	5.9	17	100	0.290

	≥ 14 inci	50	74.6	16	23.9	1	1.5	67	100	
	Headache									
16	< 14 inci	5	29.4	9	52.9	3	17.6	17	100	0.216
	≥ 14 inci	21	31.3	43	64.2	3	4.5	67	100	

Symptoms of red eyes can be caused by mechanisms on the ocular surface and other causes, such as decreased blinking frequency during screen time, corneal surface exposure to blue light from gadgets, use of contact lenses, and use of topical medications (Bhattacharjee & Nanda, 2021). The results of this study align with the study of Logaraj et al. (2014) which found a significant relationship between increased screen time and symptoms of red eyes, especially in subjects with 4-6 hours of screen time (Logaraj et al., 2014). In addition, red eyes are also the most frequent symptom of CVS (Noreen et al., 2016).

The results showed that the most common ocular symptom was blurred vision 40.9% (Iqbal et al., 2021). Abnormality of the tear glands, eye fatigue, and the angle when using a smartphone can all contribute to blurred vision. In addition, symptoms of blurred vision can be caused by various factors, namely accommodation mechanisms, especially in small screen size, eye distance from the screen, viewing angles to the screen, screen glare, poor screen lighting, and uncorrected refractive errors (Alemayehu & Alemayehu, 2019; Bhattacharjee & Nanda, 2021; Iqbal et al., 2018).

Table 3. Smartphone Size and CVS Symptoms

No.	Smartphone Size	No Symptoms		Mild + Moderate Symptoms		Severe Symptoms		Total		p-value
		N	%	N	%	n	%	N	%	
	Burning eyes									
1	< 5.8 inci	9	81.8	2	18.2	0	0	11	100	1.000
	≥ 5.8 inci	60	82.2	13	17.8	0	0	73	100	
	Itchy eyes									
2	< 5.8 inci	4	36.4	7	63.5	0	0	11	100	0.786
	≥ 5.8 inci	31	42.5	41	56.2	1	1.4	73	100	
	Foreign body sensation									
3	< 5.8 inci	8	72.7	3	27.3	0	0	11	100	1.000
	≥ 5.8 inci	49	67.1	24	32.9	0	0	73	100	
	Watery eyes									
4	< 5.8 inci	2	18.2	9	81.8	0	0	11	100	0.485
	≥ 5.8 inci	26	35.6	45	61.6	2	2.8	73	100	
5	Excessive blinking									
	< 5.8 inci	7	63.6	4	36.4	0	0	11	100	0.740

	≥ 5.8 inci	50	68.5	23	31.5	0	0	73	100	
	Red eyes									
6	< 5.8 inci	4	36.4	7	63.6	0	0	11	100	0.042*
	≥ 5.8 inci	51	69.9	22	30.1	0	0	73	100	
	Eye pain									
7	< 5.8 inci	7	63.6	4	36.4	0	0	11	100	1.000
	≥ 5.8 inci	44	60.3	29	38.7	0	0	73	100	
	The sensation of heaviness in the eyes									
8	< 5.8 inci	6	54.5	5	45.5	0	0	11	100	1.000
	≥ 5.8 inci	43	58.9	29	39.7	1	1.4	73	100	
	Dry eyes									
9	< 5.8 inci	7	63.6	4	36.4	0	0	11	100	0.638
	≥ 5.8 inci	35	47.9	36	49.3	2	2.7	73	100	
	Blurred vision									
10	< 5.8 inci	2	18.2	8	72.7	1	9.1	11	100	0.031*
	≥ 5.8 inci	41	56.2	31	42.5	1	1.4	73	100	
	Double vision									
11	< 5.8 inci	9	81.8	2	18.2	0	0	11	100	1.000
	≥ 5.8 inci	62	84.9	10	13.7	1	1.4	73	100	
	Difficulty focusing on near object									
12	< 5.8 inci	11	100	0	0	0	0	11	100	0.110
	≥ 5.8 inci	55	75.3	18	24.7	0	0	73	100	
	Increased light sensitivy									
13	< 5.8 inci	6	54.5	5	45.5	0	0	11	100	0.524
	≥ 5.8 inci	47	64.4	26	35.6	0	0	73	100	
	Colored halos around an object									
14	< 5.8 inci	11	100	0	0	0	0	11	100	0.587
	≥ 5.8 inci	66	90.4	7	9.6	0	0	73	100	
	Worsening vision									
15.	< 5.8 inci	8	72.7	3	27.3	0	0	11	100	1.000
	≥ 5.8 inci	52	71.2	19	26	2	2.7	73	100	
16	Headache									
	< 5.8 inci	3	27.3	7	63.6	1	9.1	11	100	1.000

The limitations of this study are as follows: 1) screen time was obtained from data on an apllication that indicates gadgets activities, so it cannot be guaranteed that the subjects were actually engaging in screen-related activites, 2) there are other unknown factors in this study that also influence the onset of CVS, such as the font size on the gadget, the angle of the gadget screen in

relation to the eyes, and posture when using the gadget, and 3) CVS symptoms were measured subjectively using a questionnaire.

CONCLUSION

The results showed that 59.5% of the 84 subjects experienced CVS symptoms. The average screen time of subjects on smartphones was 7.22 ± 3.01 hours/day, on laptops 6.03 ± 3.49 hours/day, and a total of 13.25 ± 4.33 hours/day. The subject uses a laptop 14 (11 - 16) inches and a smartphone 6.4 (4.7 - 6.7) inches. The results showed a correlation between screen time and CVS scores, differences in symptoms of excessive blinking between groups with laptop sizes ≤ 14 inches and > 14 inches, as well as differences in symptoms of redness of the eyes and symptoms of blurred vision between groups with smartphones < 5.8 inches and smartphones ≥ 5.8 inches. It can be concluded that there is a relationship between screen time and gadget size with CVS.

Due to limitation in this study, it is recommended to conduct a simliar study by adding questions related to the subjects' activities when the gagdet is turned on, such as whether the subjects frequently fall asleep or engage in other activities without looking at the gadget screen, conducting direct observation to determine the subjects' posture when using gadget, and measuring CVS symptoms objectively, such as measuring blinking frequency and the amount of tears produced by the subjects.

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