# Sleep Quality and Screen Time as The Most Influential Factor of Computer Vision Syndrome

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## ABSTRACT

***Background:*** *Since the Covid-19 Pandemic hit Indonesia, college students have had many eye health complaints; one is Computer Vision Syndrome (CVS). Factors that can increase the risk of CVS are decreased sleep quality, high computer/laptop use duration, and a non-ergonomic position. This study aimed to prove the relationship between sleep quality, visibility, and screen time on the incidence of CVS in medical students of Diponegoro University.*
***Method:*** *This cross-sectional study, including 147 medical students was conducted using primary data from questionnaires of Wendy Strouse Watt, Thomas H Murphy, Hospitality Eye Care Center, and vsp.com to gain data on respondent identity, visibility, and screen time. Sleep quality data were taken from the PSQI and CVS data through the CVS-Q questionnaire. Chi-square, Mann-Whittney, and logistic regression of multivariate analysis were used to analyze the data.*
***Results:*** *From 147 subjects, 108 were CVS (73.5%), and 39 were Non-CVS (26.5%). Variables of sleep quality and screen time (total) showed a significant relationship with CVS, which had p-values of p=0.001 and p=0.009 (p<0.05). As for the visibility to CVS, there was no relationship with p=0.863. In the multivariate test, sleep quality (p=0.000; ExpB=4.342) and total screen time (p=0.006; ExpB=3.913) were the most influential variables. The results showed that Computer Vision Syndrome is ubiquitous among Diponegoro University's final-year medical students. Sleep quality and total screen time can increase the risk of CVS by four times. This study also shows that CVS still appears in the post-pandemic era.*

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## INTRODUCTION

Anticipating the spread of the virus, the government has banned face-to-face learning through the The Ministry of Education, Culture, Research, and Technology Circular No. 1 of 2020, so universities must hold all lectures online.[1] Application of the online lecture method can increase gadget consumption for students because all lectures are done from morning to evening, which can harm health, particularly vision, one of which is Computer Vision Syndrome (CVS). CVS, also known as Digital Eye Strain, is a group of symptoms in vision and eyes caused by eye activity that impairs near vision before, during, or after using a device. Common CVS symptoms include headaches, eye strain, blurred vision, dry eyes, neck pain, and shoulder pain.[2] Several factors contribute to these symptoms, including poor lighting, visibility, and non-ergonomic sitting posture.[3–5]

The Ministry of Education, Culture, Research, and Technology's online learning policy can increase gadgets consumption, so the number of CVS symptoms also increases among students. This policy is consistent with the fact that the incidence of CVS is increasing among college students. A study by Patil et al. (2019) found that 77.5% of students reported CVS.[6] Basnet et al. (2018) report that 74% of medical students who use gadgets for more than 2 hours per day suffer one or more CVS clinical symptoms.[7] The rising prevalence corresponds with increasing exposure to gadgets, which was less than 3 hours per day before the Pandemic and now is more than 3 hours per day, with visibility less than 20 feet.[8] According to Ganie (2018), this causes eye fatigue complaints. It can happen due to exposure to blue light or LEDs (Light-Emitting Diodes) from gadgets.[9]

Blue light can cause permanent photochemical damage to the eyes because it has a short wavelength.[6] It causes the focus to shift to the front of the retina rather than the center, therefore increasing screen time can cause eye fatigue symptoms to worsen.[10] Effects of continuous gadget usage will impact melatonin production to decrease. It disrupts the circadian phase and causes poor sleep quality. Dwajani et al. (2020) discovered increasing screen time impacts sleep patterns, mental health,

productivity, and student welfare during the COVID-19 pandemic.[11]

Medical students are constantly subjected to high academic pressure, affecting their sleep habits. Poor night sleep and excessive daytime sleepiness were common happened among medical students. About 90% of medical students suffered from CVS and had poor sleep quality.[12,13] Study in 2019 also found 75.49% of students with CVS had poor sleep quality.[6] Poor sleep quality can be caused by increasing the duration of using computers or cell phones at night before bed. Besides, poor sleep quality contributes to other health issues, including stroke, heart disease, and obesity.[14]

Based on this description, sleep quality and screen time are related variables in the incidence of CVS. Increasing screen time can trigger a decrease in melatonin and a rise in corticosteroids.[15] As a result, poor sleep quality arises, exacerbated by eye damage due to direct blue light emission. However, the relationship between these two variables has not been known in previous studies. Hence this topic can be the attractiveness of this study. In the screen time variable, two different cut-off values were found in previous research, namely 4 and 6 hours.[16,17] This also needs to be investigated. Furthermore, there were differences in results on visibility variables between previous studies. It also can be examined the correlation and theory underlying these results. This study aimed to prove the relationship between sleep quality, visibility, and screen time on the occurrence of Computer Vision Syndrome in medical students at Universitas Diponegoro. Although research on CVS is standard, the topic between CVS and those variables in the pandemic era has not been studied before. Medical students tend to suffer CVS due to high academic pressure, so this research only involved homogenizing the subjects and avoiding bias.[13] This research would increase the awareness of students who have a class in the pandemic era. This study also can be a reference or advice for practitioners to educate patients with the same problem as the topic.

## METHOD

This research was an observational analytic study with a cross-sectional design using primary data. This study was conducted online from May to June 2022 through the questionnaires shared online using google Forms to each respondent by chat. The research participants were 235 students of the Medical Study Program, Faculty of Medicine, Universitas Diponegoro. Hereafter, all participants were selected based on inclusion and exclusion criteria. Hence, the total of all subjects was 147 students.

Inclusion criteria were Medical Students in the Faculty of Medicine, Universitas Diponegoro Class of 2019 who were willing to participate in research, using a laptop/computer with or without dark mode or night mode features. They had ametropia or mild refractive error (<3 diopters). Incomplete filling of questionnaires, use of artificial tears or eye drops, use of drugs (antihistamines, anti-anxiety, antidepressants, or oral steroids), history of severe eye disease (such as glaucoma, retinal disease, and eye infections), and neurological, psychiatric, and sleep disorders were all exclusion criteria for this study.

This study conducted univariate, bivariate, and multivariate analyses. Univariate analyses determined subjects' distribution and characteristics using frequency and percentage. Using Chi-Square and Mann-Whitney test, bivariate analysis was used to determine the relationship between variables. The nominal data were analyzed with a bivariate Chi-Square test with $p < 0.05$ is significant. On ordinal data, if the value of the expected count in the Chi-Square test was more than 20%, then the alternative test used next was Mann-Whitney with $p < 0.05$ also showed significance. Hereafter, the multivariate test was used to know the most influential variables with CVS. A value of $p < 0.25$ is the requirement for the logistic regression test. Results will be significant if it reaches a value of $p < 0.05$. This study has been granted permission by The Health Research Ethics Commission, Faculty of Medicine, Universitas Diponegoro, with the number 114/EC/KEPK/FK-UNDIP/V/2022.

## RESULTS AND DISCUSSION

This research acquired 234 participants who filled out the questionnaires, and only 147 were selected based on inclusion criteria. According to the data, there were 108 CVS subjects (73.5%) whom 72 subjects were women, and 36 were men. Additionally, Table 1 shows 23,1% or 25 CVS subjects have good sleep quality, whereas 76,9% or 83 other CVS subjects have poor sleep quality. Screen time and visibility datum support the high number of CVS patients and poor sleep quality. 59 CVS subjects (54,6%) usually used a computer/laptop within < 50 cm. Then, continuous computer/laptop usage for > 4 hours was also found in 69 CVS subjects (63,9%), while total exposure to computers/laptops per day (> 6 hours) was obtained in 96 CVS subjects (88,9%). Unlike non-CVS subjects, the percentage tends to be low compared to CVS subjects.

In line with the 2018 study, 86% of medical students in Egypt complained of CVS with more than 3 hours of gadget use per day.[4] The study of Abudawood et al. revealed that 95% of undergraduate students in Saudi Arabia experienced CVS, with 77.4% being medical students.[18] Furthermore, the study of Akowuah et al. showed a CVS prevalence of 64.36% among university

students in Ghana.[17] In the present study, 73.5% or 108 subjects from all final-year medical students suffered from CVS. These results are not much different from previous studies, which stated that the prevalence of CVS among university students was still high. According to Maheshwari's study, medical students spend their time, especially at night, with academic matters requiring them to use gadgets constantly.[13] This statement decreases sleep duration because exposure to blue light on gadgets inhibits melatonin production, disrupting circadian regulation.[19]

Table 2 shows sleep quality and screen time have a significant relationship with CVS incidence, with p-values of 0.001 and 0.009 (p-value < 0.05). There is no significant relationship between visibility and continuous screen time with a cut-off of 4 hours. Then, the results from Table 2 were filtered for multivariate logistic regression analysis with a requirement of p-value < 0.25 in bivariate analysis. Only sleep quality and total screen time per day could be analyzed with logistic regression. The results are shown in Table 3, in which both sleep quality and screen time are the most influential factor for CVS.

The previous study showed an independent and combined effect of screen lighting, intensity, and wavelength of light on sleep physiology.[20] These results support the theory that blue light can regulate sleep and activate the arousal system.[10,21] Then, the study of Gabel et al. found weak melatonin levels in subjects exposed to gadget light at night, both young and old subjects.[15] This theory supports the results of this study which found a significant relationship between sleep quality and CVS. Subjects with poor sleep quality were found in 83 people (76.9%) who suffered from CVS. These results align with Patil et al.'s research, which got the subject as many as 75.49% of CVS students experienced poor sleep quality.[6] Research by El Hangouche et al. also got the same result, 63.6% of final-year medical students experienced poor sleep quality.[12] These studies' poor sleep quality is caused by high screen time, especially at night. This study also aligns with Lima et al., who found their subjects using gadgets before bed.[14] Nayak et al., in their study, also found that the subjects experienced eye fatigue after or when using gadgets.[22]

In line with the sleep quality results, high screen time was also seen in this study. As many as 88.9% of CVS subjects were exposed to blue light for 6 hours daily, and 63.9% were exposed continuously for 4 hours. However, only screen time of 6 hours had a significant relationship with CVS. With a cut-off value of 4 hours, this result is not in line with Pratiwi's study but is in line with Medelin's study.[16,23] The difference in results can be caused by all respondents who apply a break between gadget use. The existence of rest breaks in various ways, such as the 20-20-20 technique, can relax the accommodation power and increase eye comfort.[16,24,25] In addition, all respondents in this study have understood and applied for the ergonomic position in using gadgets. That statement supports the results of this study which the variable visibility has no relationship with CVS.

**Table 1.** Characteristics of the subject in this study

| Variables | CVS | | Non CVS | |
|---|---|---|---|---|
| | n | % | n | % |
| **Sex** | | | | |
| Men | 36 | 33.3 | 17 | 43.6 |
| Women | 72 | 66.7 | 22 | 56.4 |
| **Sleep quality** | | | | |
| Good | 25 | 23.1 | 21 | 53.8 |
| Poor | 83 | 76.9 | 18 | 46.2 |
| **Visibility (cm)** | | | | |
| < 50 | 59 | 54.6 | 20 | 51.3 |
| ≥ 50 | 49 | 45.4 | 19 | 48.7 |
| **Continuous screen time (hour)** | | | | |
| < 4 | 39 | 36.1 | 17 | 43.6 |
| ≥ 4 | 69 | 63.9 | 22 | 56.4 |
| **Total screen time (hour)** | | | | |
| < 6 | 12 | 11.1 | 12 | 30.8 |
| ≥ 6 | 96 | 88.9 | 27 | 69.2 |

**Table 2.** Chi-Square test results in independent variables

| Variables | f | Mean | SD | Variants | p-value |
|---|---|---|---|---|---|
| **Sleep quality** | | | | | |
| Good | 46 | 1.69 | 0.443 | 0.216 | 0.001 |
| Poor | 101 | | | | |
| **Visibility (cm)** | | | | | |
| < 50 | 79 | 1.46 | 0.500 | 0.250 | 0.863 |
| ≥ 50 | 68 | | | | |
| **Continuous screen time (hour)** | | | | | |
| < 4 | 56 | 1.62 | 0.487 | 0.237 | 0.527 |
| ≥ 4 | 91 | | | | |
| **Total screen time (hour)** | | | | | |
| < 6 | 24 | 1.84 | 0.371 | 0.138 | 0.009 |
| ≥ 6 | 123 | | | | |

**Table 3.** Multivariate logistic regression test of independent variables

| Variables | Sig. | ExpB | 95% CI for ExpB | |
|---|---|---|---|---|
| | | | Lower | Upper |
| Sleep quality | 0.000 | 4.342 | 1.935 | 9.743 |
| Total screen time | 0.006 | 3.913 | 1.486 | 10.298 |

**Table 4.** Multivariate logistic regression test in CVS symptoms

| CVS Symptom | p-value |
|---|---|
| Eye pain | 0.036 |
| Dryness | 0.016 |
| Increased sensitivity to light | 0.015 |
| Worsening of sight | 0.094 |

**Table 5.** Chi-square and Mann-Whitney in PSQI component score

| Component | p-value |
|---|---|
| Component 1: Subjective quality of sleep | 0.100 |
| Component 2: Sleep duration | 0.773 |
| Component 3: Sleep latency | 0.494 |
| Component 4: Sleep efficiency | 0.324 |
| Component 5: Sleep disturbance | 0.002 |
| Component 6: Sleeping pills use | 0.295 |
| Component 7: Daytime disfunction | 0.000 |

In contrast to Insani's study, visibility has a significant relationship with CVS because the subject paid less attention to ergonomic position.[5] The application of an ergonomic position can be one of the prevention and reduce eye discomfort.[26] Of the three main variables in this study and through multivariate testing, sleep quality and screen time (total) were the most influential variables on CVS. Sleep quality and screen time (total) can increase the risk of CVS by four times.

This study also found the most dominant CVS symptom complaints. Table 4 shows CVS symptoms which most frequently are complained about by subjects. The results are significant with p-value < 0.05, found in eye pain, dryness, and increased sensitivity to light, while the symptom of worsening sight is insignificant (p-value = 0.094). The three CVS symptoms were included in the top 7 highest complaints in the study of Abudawood et al.[18] Dry eyes and tired eyes were the most common symptoms of CVS in the study of Ranasinghe et al. and

Sheppard.[27,28] Blue light exposure can increase corticosteroids, which impacts decreased parasympathetic nervous excitability and reduced tear secretion. So the eyes dry faster.[10,15]

Score components of PSQI were also tested to know the relationship between components with CVS incidence. Table 5 shows only components 5 (p-value = 0.002) and 7 (p-value = 0.000) which have a significant relationship to CVS incidence in the subject (p-value < 0.05). On the contrary, components 1, 2, 3, 4, and 6 with p-value > 0.05 are insignificant with CVS incidence. These components, 5 (sleep disturbance) and 7 (day dysfunction) contribute to the poor sleep quality of CVS subjects. A study by Patil et al. found no significance in components 1, 3, and 6.[6] In this study, components 2 and 4 are unrelated because two components in the overall assessment of the PSQI score are also part of components 1 and 3, which are subjective. In component 6, the use of drugs was not found in this study because it was an exclusion criterion.

During the study, there were several limitations, namely the absence of a direct refraction check to determine visual acuity and not homogenizing features or brightness in computer/laptop, which could affect the validity of the data. Covid-19 has subsided, so some courses require going offline during May and June, which is the time of data collection and the difference in the time of filling out the questionnaire between subjects which has the potential to cause subject information updating bias. However, there is also a strength of this study. This study could reach many respondents to represent medical students' condition regarding their eye health. This research was carried out amid the Covid-19 outbreak, which began to subside, so the results of this study are a renewal that can be a reference for future research about CVS. The clinical implication of this study is that CVS can affect the hormonal and physiological regulation of the body.

## CONCLUSION

Computer Vision Syndrome (CVS) is ubiquitous among Diponegoro University's final-year medical students. Results show that visibility does not affect the occurrence of CVS. In contrast, sleep quality and total screen time have a significant relationship. They are the most influential variables and can increase the risk of CVS by four times. This study also shows that CVS still appears in the post-pandemic era, especially among college students.

Future research might include direct eye refraction examination, and homogenization of the computer/laptop conditions can be carried out to support the study's results to be more accurate. In addition, there is a need for further development of this topic to compare the incidence of Computer Vision Syndrome during online learning with offline learning or the era before, during, and post-covid-19 pandemics.

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## CONFLICTS OF INTEREST

The authors declare no potential conflict of interest.

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