



## Relationship between smartphone usage duration and the risk of eye strain complaints



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### ABSTRACT

**Background:** A smartphone is a device that is widely used by various groups, one of which is college students. The use of smartphones by college students can be seen from their needs in the learning process. Smartphones are one of the most significant sources of electromagnetic waves that, if used excessively, might affect eye health. Eye strain is a complaint to the eyes that generally occur due to excessive smartphone use.

**Objective:** This study aimed to examine the relationship between the duration of smartphone use and undergraduate students' eye strain risk.

**Methods:** This study was a cross-sectional analytical observational study between September 2022 and December 2022. The 104 students in the Physiotherapy Study Program at Faculty of Medicine, Universitas Udayana, who ranged in age from 20 to 23, were the study's participants. Total sampling was used as a non-probability sampling technique.

**Results:** The results of the study found that 16 people (15.4%) had an excellent smartphone usage duration of  $\leq 4$  hours and 88 people (84.6%) had a lousy smartphone usage duration of  $> 4$  hours. The results of the Spearman Rho non-parametric analysis test showed a relationship between the time of smartphone use and eye strain complaints in students ( $p= 0.001$ ) with a positive coefficient ( $r= 0.328$ ).

**Conclusion:** There was a significant relationship between the duration of smartphone use and undergraduate students' eye strain risk.

**Keywords:** duration of smartphone use, eye strain, university student.

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### INTRODUCTION

Technology is advancing quickly across all industries, particularly in the information and communication sector. A smartphone digital gadget is the outcome of technological advancements in information and communication. Along with the times, smartphones in everyday life cannot be avoided and will continue to increase yearly.

A smartphone is a cell phone with a built-in application and access to the internet. Smartphones also have digital voice services, text messaging, e-mail, and other computer functions. Besides providing built-in features, smartphones also have operating systems capable of running downloaded.<sup>1</sup>

Based on data for 2014, it was found that active smartphone users throughout Indonesia reached 47 million people, of which 79.5% came from the age category of

children and adolescents. In the latest data published by Hootsuite in January 2018, the number of smartphones connected to the internet has reached 338.2 million units, nearly double the amount of active internet users in Indonesia, which was discovered to be 175.4 million out of a total of 272.1 million individuals.<sup>2</sup> Data on active internet usage in Indonesia found that the most internet accesses with smartphones were on the islands of Java and Bali, around 92%.<sup>3</sup> This shows that smartphones and Internet use in Indonesia have reached relatively high numbers, especially among children, adolescents and college students.

The use of smartphones by college students today can be seen from their needs in the learning process, one of which is the need to get information quickly through valid or trusted sources. The academic method of teaching and learning through Internet facilities is integral to

student learning life. Therefore, along with the times and technology, the means of using the internet are increasingly easy to obtain. One of the ingredients is the use of smartphone media.<sup>4</sup> According to research data by Jung & Yimin 2014, it was found that smartphones were more widely used among students, with practitioners using a percentage of 66.9% and as much as 33.1%.<sup>5</sup> The duration of smartphone use among students has reached nine hours daily. This use lasts longer than the time students use to sleep.<sup>4</sup> This long duration of smartphone use can affect the students' health, especially problems related to eye health, which is an essential asset for humans, especially students.

Smartphones are one of the primary sources of electromagnetic waves, which, if used excessively, can impact eye health. According to data, around 60,000,000 people experience eye disorders, which has increased by 1,000,000 yearly.<sup>6</sup>

According to the 2016 Digital Eye Strain Report from the Vision Council, up to 70% of Americans use two or more digital devices simultaneously, and nearly 90% use their smartphones for two hours or more daily. About 60% of Americans use smartphones for five hours or more daily. Sixty-five percent of Americans report that they experience eye strain symptoms.<sup>7</sup>

Overusing the ocular accommodation muscles results in eye strain or eye fatigue, a subjective symptom. When the eye muscles work hard, mainly when focusing on close objects for an extended period, symptoms like tired, tight, or hurting eyes are frequently felt. Eye strain usually appears with signs of irritation, for example, symptoms of watery eyes, red eyelids, sore eyes, itching, dryness, drowsiness, double vision, blurred vision, tension, headaches, decreased eye sharpness, the strength of convergence and accommodation fell eyesight, dizziness accompanied by nausea, difficulty focusing and can reduce concentration.<sup>8</sup> In particular, eye strain or fatigue caused by excessive screen display (computer or smartphone) is also defined as computer vision syndrome (CVS), which usually presents with ocular, visual, and musculoskeletal complaints, particularly in the shoulders and neck.<sup>9</sup>

Based on data from the world health organization (WHO), the prevalence of complaints of eye fatigue (eye strain) worldwide has reached 75% - 90%. In Indonesia, most eye fatigue varies from 40% to 92%.<sup>10</sup> Based on research conducted by Munif et al. (2020), It was discovered that 113 samples (96.6%) of students complained of eye fatigue as a result of using digital gadgets for more than 4 hours per day.<sup>11</sup> The national institute of occupational safety and health (NIOSH) recommends that the duration of using a smartphone or computer digital device is no more than 4 hours a day. Taking a 15-minute pause from using a digital smartphone or computer device is also advised by the national institute of occupational safety and health, which aims to reduce eye muscle fatigue so that digital smartphone and computer device users will feel more comfortable.<sup>12</sup> Someone who has a habit of using a smartphone digital device for a long duration will usually be at risk of eye damage, where the practice of

using a smartphone automatically requires the user to make direct eye contact with a smartphone screen continuously for a long duration of time, coupled with a smartphone screen display that is too bright can enlarge and accelerate a person's risk of experiencing eye fatigue.

Since the COVID-19 epidemic broke out in 2019, practically all social interactions, including lecture activities, have occurred online. Universitas Udayana is one of the universities that run the lecture process through the online realm. The transition to lectures and other activities indirectly affects students' use of digital devices, including smartphones. Based on brief subjective interviews conducted by researchers on 10 students of the Physiotherapy Study Program, Faculty of Medicine, Universitas Udayana with the characteristics of 5 male students and 5 female students with an average duration of use smartphone for 6 hours/day, as many as 10 students said they experienced eye strain symptoms such as eyes feeling tired, watery, itchy, and hot when using smartphones every day.

Based on the background above, the researchers believe that the factor of the duration of smartphone use, especially excessive use, can affect the risk of eye strain complaints. It is hoped that this research can be used to add to data from a study that has been done before and can become a reference for the health sector and society so that it can be a form of education and prevention related to excessive smartphone use and the risks it causes.

## METHODS

This study used a cross-sectional design and a quantitative analytical survey research approach. From September through December 2022, this study was carried out at the Faculty of Medicine, Universitas Udayana. The subjects for this study were selected using a total sampling approach, meaning that all samples that satisfied the inclusion and exclusion criteria were used. The inclusion criteria in this study were active students of the Physiotherapy Study Program, Faculty of Medicine, Universitas Udayana, owning and operating a smartphone digital device, having 6/6 normal vision (with or without

the aid of correction tools), and being willing to participate in research and give written consent. The exclusion criteria in this study were that the subject still needed to complete the questionnaire. One hundred four research volunteers were used as participants in this investigation. The time spent utilizing smartphone digital devices is the study's independent variable. Student complaints of eye strain are the study's dependent variable. The control variables in this study were age, gender, and eye refractive error.

Total sampling was employed in this study, and the participants were all samples matching the inclusion and exclusion criteria. The subject's eye vision was assessed using the Snellen Chart following the inclusion criteria. Subjects who have abnormal eye vision will be excluded from the study. Eye fatigue was measured using the computer vision syndrome questionnaire (CVS-Q). There are 16 questions in this questionnaire about the effects of eyestrain, including headaches, double vision, blurred vision, and other symptoms. This CVS-Q questionnaire assesses the frequency of the signs it asks about with the answer choices of "never," "sometimes," and "often or always." if the participant answers "sometimes" or "often or always," the participant will be prompted to select either "moderate" or "strong" as the severity of the symptom. the subject is deemed to have complaints of eye tiredness or eye strain if they receive a total score  $\geq 6$ .<sup>13,14</sup>

The track record program, which calculates the average and daily usage times per smartphone, was used to measure the duration of smartphone use in this study. The application used in this study is the "your hour" application which can be downloaded for free via the Google play store. this application has also been used in previous research and has been published in research by Grimaldi-Puyana M. et al. in 2020.<sup>15</sup>

This study utilized Both univariate and bivariate analyses as statistical tests. Univariate analysis was carried out to determine the characteristics and frequency distribution of the duration of smartphone use, eye strain complaints, age, and refractive errors of the sample's eyes. The smartphone use time and

eye strain among college students were measured using bivariate analysis, and the bivariate analysis used Spearman's rho test.

## RESULTS

Subjects in this study amounted to 104 samples that met the inclusion and exclusion criteria taken through the total sampling technique. The data were discovered in the table below after data collection and analysis utilizing Spearman's rho for univariate and bivariate data.

Based on Table 1, 16 people (15,4%) had an excellent smartphone usage duration of  $\leq 4$  hours and 88 people (84,6%) had a lousy smartphone usage duration of  $> 4$  hours. Based on the results of the CVS-Q questionnaire, as many as 70 people (67,3%) experienced eye strain complaints and 34 people (32,7%) did not experience eye strain complaints.

Table 2 shows that the Spearman correlation test had a  $p$ -value of 0.001 for the analysis. Based on these findings, the judgment is made that  $H_0$  is rejected and  $H_a$  is approved if the value of  $A_{\text{symp}}$ . Sig (2-sided) or  $p < 0.050$  indicates a relationship between smartphone use duration and eye strain risk.

According to the Spearman rho non-parametric analysis test results, the relationship between the time spent using a smartphone and complaints of eye strain was significant ( $p = 0.001$ ), with a positive Spearman correlation value of 0.33. This shows a powerful, weak, and directly proportional correlation between the duration of smartphone use and eye strain complaints in students of the Undergraduate Physiotherapy Study Program, Faculty of Medicine, Universitas Udayana. A directly proportional relationship means that the higher the duration of smartphone use, the higher the eye strain incidents are.

## DISCUSSION

The duration of smartphone use influences various pathological conditions, including eye strain or eye fatigue. The mechanism of eye strain is caused by stress that occurs in the accommodation muscles of the eye which. The accommodating power (ciliary body) will become tense if it persists.

**Table 1. Characteristics of respondents**

Characteristics	Frequency	Percentage
Duration of Smartphone Usage		
Good	16	15.4
Bad	88	84.6
Computer Vision Syndrome Questionnaire		
Eye Strain	70	67.3
Not Eye Strain	34	32.7
Age		
20	27	26.0
21	36	34.6
22	39	37.5
23	2	1.9
Gender		
Male	33	31.7
Female	71	68.3

**Table 2. Results of the Spearman's rho correlation test for the relationship between duration of smartphone use and risk of eye strain**

Variable Correlation	Correlation	P-value
Duration of smartphone use risk of eye strain	0.33	0.001

This condition triggers the production of lactate acid, and as a result, there will be effects in the form of eye fatigue. Stress on the retina can also occur when there is excessive contrast in the area of vision of the eye and for an extended period of observation.<sup>16</sup>

Symptoms of eye strain can appear after using digital devices (smartphones) for more than 4 hours.<sup>17</sup> Eye accommodation that lasts a long time and occurs continuously will reduce one's capacity to see close to the eyes and cause several disorders such as headaches, watery eyes, heat, and pain in the eyes.<sup>18</sup>

The findings of this study are consistent with research done in 2018 by Azzibaginda Ganie et al., which found a connection between the frequency of eye strain and the amount of time students spent using their smartphones at the University of Lampung's Faculty of Medicine. This study used 66 subjects and obtained significant positive results with a substantial correlation. This shows that the higher the level of duration of smartphone use will also be followed by an increase in the incidence of eye strain in students. Smartphone users use smartphones at a distance that tends to be close and will impact increasing eye accommodation power, and the workload of the ciliary muscle will be more significant. Long duration

will also affect the onset of eye fatigue.<sup>19,20</sup>

This is caused by the ability of the eye muscles to maintain their contractions for an extended period so that ciliary muscle contractions occur continuously, which causes fatigue reactions in the eyes.<sup>21</sup> Yondhi also conducted A similar study in 2021, where the study's findings revealed an association between the frequency of smartphone use and the incidence rate of eye strain, with sufficient strength and a positive direction correlation, indicating that the longer a person uses a smartphone, the more frequently they experience eye strain.<sup>22</sup> The strength of this study lies in its ability to explain the relationship between the duration of smartphone use and the likelihood of eye fatigue complaints in physiotherapy students at the Faculty of Medicine, Universitas Udayana. It also gives a general overview of students' recommended amount of smartphone use time. However, the limitations of this study include that researchers cannot control other factors and confounding variables such as smartphone exposure distance, room lighting, and the use of other electronic media/devices (e.g., laptops, computers, TVs, etc.). In addition, the target population in this study is at the study program level, which, in further research, can be increased at the faculty and university levels.

## CONCLUSION

Based on the results of the research, it can be concluded that there was a significant positive correlation between the duration of smartphone use and the risk of eye strain complaints in undergraduate physiotherapy students, Faculty of Medicine, Universitas Udayana. Future researchers can develop and conduct further research on variables that are considered confounding variables in this study to minimize bias and increase the significance of the results of the investigation.

## ETHICAL CLEARANCE

The Research Ethics Commission, College of Medicine, Universitas Udayana, stated that this research is ethically feasible with number 1979/UN14.2.2.VII.14/LT/2022.

## CONFLICT OF INTEREST

This study has no conflicts of interest.

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## AUTHOR CONTRIBUTIONS

TGBWP prepared the study design, collected data, processed data, and wrote the manuscript. NLNA, IVJ, and MHSN have organized the study design, directed data collection, and revised the manuscript.

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