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THE RELATIONSHIP BETWEEN GADGET USE AND THE INCIDENCE OF MYOPIA AMONG HIGH SCHOOL STUDENTS DURING ONLINE LEARNING

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ABSTRACT

Introduction: Online learning is a solution to inhibit the transmission of viruses during the COVID-19 pandemic. However, students can be exposed to prolonged use of gadgets which can cause myopia. This study aimed to determine the relationship between gadget use and the incidence of myopia in students at SMA Muhammadiyah 1 Pekajangan Pekalongan during online learning.

Method: This study was a correlational study with a cross-sectional approach. The sample was 121 students from grades XI and XII selected by convenience sampling technique. Data were obtained using an online questionnaire. Chi Square test was used in bivariate analysis. Binary logistic regression was used in multivariate analysis.

Results: The incidence of myopia in SMA Muhammadiyah 1 Pekajangan Pekalongan was 43.8%. Students who used gadgets with a duration of > 6 hours were at risk of myopia by 9.733 times compared to students who used gadgets <= 6 hours (p-value 0.001). Compared to students who used gadgets with moderate light intensity, students who used gadgets with bright intensity had a 50.058 times greater risk (p-value 0.002), students who used gadgets with dim light intensity had a 6.861 times greater risk (p-value 0.015). Students who used gadgets with a distance < 30 cm had a risk of myopia of 15.030 times compared to students who used gadgets with a distance >= 30 cm (p-value 0.013).

Conclusion: There is an association between gadget use (in terms of duration, light intensity, and distance) and the incidence of myopia, even after controlling for genetic factor.

Keywords: *Gadget, Myopia, Student, Pandemic*

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INTRODUCTION

Myopia is a state of vision in which near objects are clearly visible, but distant objects are blurred (Landreneau, Hesemann, & Cardonell, 2021). It has been reported by other studies that myopia is prevalent among school students. A study in Sumatra involving 220 high school students reported a prevalence of myopia of 60.45% in urban areas and 14.55% in rural areas (Avliwani & Amra, 2018). Another study in Banda Aceh of 197 junior high school students reported a prevalence of myopia of 20.5%, and all did not wear corrective glasses (Basri, Pamungkas, & Arifian, 2020). A study in Bandung on 435 junior high school students reported a prevalence of refractive errors (mostly myopia) of 18.39% (Nikmah, Rifada, & Santoso, 2016). A literature review reported that the prevalence of myopia is higher in Asia (60%) compared to Europe (40%) or North America (42%), and even in East Asia the prevalence rate of myopia is very high (73%) (Grzybowski, Kanclerz, Tsubota, Lanca, & Saw, 2020).

The COVID-19 pandemic is considered to have contributed to the increase in myopia cases. A study by Paramita & Leonard (2021) showed that the progression of myopia cases increased significantly from 2019-2020 (the period when students were learning online at home) compared to the period 2018-2019 before the COVID-19 pandemic. Another study of school students found that home confinement during the COVID-19 pandemic significantly increased the prevalence of myopia from the pre-pandemic period (Wang et al., 2021). Home confinement increases prolonged use of gadgets in school students as learning turns online. A study shows that prolonged use of gadgets causes problems related to eye discomfort and can cause various eye problems (Sari & Himayani, 2018). A systematic review states that excessive smartphone use can cause visual impairment, as well as other disorders such as musculoskeletal disorders and interpersonal disorders (Priya & Subramaniyam, 2020). The same statement was also made by the American Academy of Ophthalmology (AAO) that prolonged use of gadgets can result in eye fatigue, redness, blurred vision and other eye symptoms (Akpek et al., 2019).

The results of our preliminary study at Senior High School (SMA) Muhammadiyah 1 Pekajangan Pekalongan with interviews and eye examinations using Snellen chart on 28 students stated that 15 students (53.6%) had myopia. In this school, student learning is carried out online during the pandemic, in accordance with government policy. The purpose of this study was to investigate the relationship between gadget use during online learning and the incidence of myopia in students.

METHOD

This study was a correlational study with a cross sectional approach. Prior to data collection, the study received ethical approval from the Health Research Ethics Committee, Faculty of Health Sciences, Pekalongan University with number 143/B.02.01/KEPK/VII/2022. The research sample was obtained using convenience sampling technique through the distribution of online questionnaire through WhatsApp. This sampling technique was considered the most feasible data collection during the COVID-19 pandemic. Previously, the researcher provided an explanation through the WhatsApp group of grades XI and XII which included the purpose, objectives, benefits, research procedures and guaranteed the confidentiality of respondent data. The researcher did not involve grade X students because they were new students and have not participated in learning activities at SMA Muhammadiyah 1 Pekajangan Pekalongan. Then the researcher asked students who were willing to become respondents to fill out a consent form. The google form link containing the questionnaire was sent via WhatsApp to students who filled out the consent form. Students who reported myopia before online learning were excluded

from the study. A total of 96 respondents participated on this study.

The independent variable in this study is the use of gadgets which includes several sub-variables, i.e. the duration of gadget use, the light intensity of gadget use, the position when using the gadget, the eye distance on gadget use, the type of gadget (mobile phone, tablet, laptop). The dependent variable in this study was the incidence of myopia. The confounding variable in this study was genetic (father/mother suffering from myopia).

The researcher used a questionnaire regarding gadget use and myopia. All the data were self-reported. The questionnaire used in this study was cited from several previous studies, 6 questions from (Hayatillah, 2011), 4 questions from (Lubis, 2018), 3 questions from (Putri, 2016) and 2 questions from (Zulma, 2015).

The data were presented using frequency and percentage for categorical variables, and using mean ± SD for numerical variables. Chi Square test was used as a bivariate analysis to test the relationship between one independent variable and the dependent variable (incidence of myopia), with a significance level of 0.05. Variables with a significance level ≤ 0.15 in the bivariate analysis were then included in the multivariate analysis model, and tested using the binary logistic regression test with a significance level of 0.05. The multivariate model also controlled for genetic factor. All statistical analyses were performed using SPSS version 22.

RESULTS

Table 1 shows the frequency distribution of respondents' characteristics based on gender, age, grade, major, and genetics (father/mother has myopia). The table illustrates that most of the respondents were female (62.5%), aged 16 years (49%), grade XII (54.2%) and majoring in natural sciences (62.5%). The average age of the respondents was 16.48 ± 0.75 years. A total of 42.7% of students had a father/mother with myopia.

Table 2 shows the frequency distribution of gadget use among students, including duration, light intensity, position, distance and type of gadget. The table illustrates that most students use gadgets > 6 hours a day (58.3%), with dim light intensity (52.1%), with a lying position (64.6%), viewing distance < 30 cm to the gadget (81.3%), and use a mobile phone (77.1%). Table 3 shows that 43.8% of students developed myopia during the online learning.

Table 1. Characteristics of Respondents (n=96)

Variables	Frequencies (%)	Means ± SD
Gender		
Males	36 (37,5%)	
Females	60 (62,5%)	
Ages (years)		16,48 ± 0,75
15 years	5 (5,2%)	
16 years	47 (49,0%)	
17 years	39 (40,6%)	
18 years	3 (3,1%)	
19 years	2 (2,1%)	
Grades		
Grade XI	44 (45,8%)	
Grade XII	52 (54,2%)	

Major	
Natural Sciences (MIPA)	60 (62,5%)
Social Sciences (IPS)	36 (37,5%)
Father/mother has myopia	
No	55 (57,3%)
Yes	41 (42,7%)

Table 2. Gadget Usage Based on Duration, Light Intensity, Position, Distance and Gadget Type (n=96)

Variables	Frequencies (%)
Duration	
<= 6 hours	40 (41,7%)
> 6 hours	56 (58,3%)
Light Intensity	
Dim	50 (52,1%)
Medium	31 (32,3%)
Bright	15 (15,6%)
Position	
Sitting	23 (24,0%)
Prone	11 (11,5%)
Lying down	62 (64,6%)
Distance	
< 30 cm	78 (81,3%)
>= 30 cm	18 (18,8%)
Gadget Type	
Mobile phone	74 (77,1%)
iPad/Laptop	22(22,9%)

Table 3. Incidence of Myopia During Online Learning (n=96)

Variable	Frequencies (%)
Myopia	
No	54 (56,3%)
Yes	42 (43,8%)

Table 4. Incidence of Myopia Based on Sample Characteristics (n=96)

Variables	Myopia		p-*value*
	No	Yes	
Gender			0,75
Males	21 (58,3%)	15 (41,7%)	
Females	33 (55,0%)	27 (45,0%)	

Ages (years)			0,701
15 years	3 (60,0%)	2 (40,0%)	
16 years	23 (48,9%)	24 (51,1%)	
17 years	25 (64,1%)	14 (35,9%)	
18 years	2 (66,7%)	1 (33,3%)	
19 years	1 (50,0%)	1 (50,0%)	
Grades			0,256
Grade XI	22 (50,0%)	22 (50,0%)	
Grade XII	32 (61,5%)	20 (38,5%)	
Major			0,167
Natural Sciences	37 (61,7%)	23 (38,3%)	
Spcial Sciences	17 (47,2%)	19 (52,8%)	
Father/mother has myopia			0,029
No	34 (66,7%)	17 (33,3%)	
Yes	20 (44,4%)	25 (55,6%)	

Table 4 shows that the proportion of students with myopia did not differ significantly by gender, age, grade, and major. However, the proportion of students with myopia who had a father/mother with myopia (55.6%) was significantly higher from the proportion of students with myopia whose father/mother without myopia (33.3%).

Table 5. Incidence of Myopia Based on Gadget Use (n=96)

Variables	**Myopia**		**p-value**
	No	**Yes**	
Duration			<0,001
<= 6 hours	34 (85,0%)	6 (15,0%)	
> 6 hours	20 (35,7%)	36 (64,3%)	
Light Intensity			<0,001
Dim	25 (50,0%)	25 (50,0%)	
Medium	27 (87,1%)	4 (12,9%)	
Bright	2 (13,3%)	13 (86,7%)	
Position			0,002
Sitting	20 (87,0%)	3 (13,0%)	
Prone	4 (36,4%)	7 (63,6%)	
Lying down	30 (48,4%)	32 (51,6%)	
Distance			0,010
< 30 cm	39 (50,0%)	39 (50,0%)	
>= 30 cm	15 (83,3%)	3 (16,7%)	
Gadget Type			0,024
Mobile phone	37 (50,0%)	37 (50,0%)	
iPad/Laptop	17 (77,3%)	5 (22,7%)	

Table 5 shows the proportion of myopia incidence based on gadget use. The proportion of students with myopia was significantly higher in students who used gadgets > 6 hours a day (64.3%)

than in students who used gadgets <= 6 hours a day (15%), with a p-value < 0.001. There was a difference in the proportion of students with myopia based on gadget light intensity (dim, medium, bright) with the highest proportion of myopia patients being students who used gadgets with bright light intensity (86.7%), compared to dim light intensity (50%) and medium light intensity (12.9%), with p-value <0.001. The proportion of students with myopia was also significantly different based on the position of gadget use, with the highest proportion being the prone position (63.6%), and the lowest being the sitting position (13%), with a p-value of 0.002. The proportion of students suffering from myopia was significantly higher in students who used gadgets with a distance < 30 cm (50%) than in students who used gadgets with a distance >= 30 cm (16.7%) with a p-value of 0.010. The proportion of students who suffered from myopia was significantly higher among students who used mobile phones (50%) than among students who used iPad/laptop (22.7%) with a p-value of 0.024

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Table 6. Multivariate Analysis of Gadget Use Associated with Myopia Incidence (n=96)*

Variables	B(SE)	OR	p-value	R^2
Duration				
<= 6 hours (ref)				
> 6 hours	2,276 (0,711)	9,733	0,001	
Intensitas Cahaya				
Medium (ref)				
Dim	1,926 (0,790)	6,861	0,015	
Light	3,913 (1,253)	50,058	0,002	
Posisi				
Sitting (ref)				0,637
Prone	1,947 (1,308)	7,008	0,137	
Lying down	1,110 (0,858)	3,033	0,196	
Distance				
>=30 cm (ref)				
< 30 cm	2,710 (1,086)	15,030	0,013	
Gadget Type				
iPad/Laptop (ref)				
Mobile phone	0,989 (0,812)	2,689	0,223	

* This multivariate model is controlled by genetic factor

Table 6 shows the results of the multivariate analysis to examine the relationship between gadget use and myopia incidence with the control of genetic factor. The multivariate model in this study could explain 63.7% of the variance of myopia incidence. Students who used gadgets with a duration of > 6 hours were at risk of myopia by 9.733 times compared to students who used gadgets <= 6 hours (p-value 0.001). Compared to students who used gadgets with moderate light intensity, students who used gadgets with bright intensity had a 50.058 times greater risk (p-value 0.002), students who used gadgets with dim light intensity had a 6.861 times greater risk (p-value 0.015). Students who used gadgets with a distance < 30 cm had a risk of myopia of 15.030 times compared to students who used gadgets with a distance >= 30 cm (p-value 0.013)

DISCUSSION

The results of this study showed that the incidence of myopia in SMA Muhammadiyah 1 Pekajangan Pekalongan was high at 43.8%, exceeding the prevalence found by studies in Aceh (Basri et al., 2020) and Bandung (Nikmah et al., 2016). This study also found that gadget use (including duration, light intensity, and distance variables) was significantly associated with myopia incidence, even after controlling for genetic variables.

The results of this study corroborated previous research conducted by (Kartikawati, Suprihatin, & Maksus, 2021) which stated that the intensity of smartphone or gadget use was associated with refractive errors in myopia cases. This is also in line with research conducted by (Khalid, 2019) which stated that there was a significant relationship between the duration of gadget use and the incidence of myopia among junior high school students in Makassar. Vision works more when looking at screens that are close and small. Prolonged use of gadgets can lead to unstoppable accommodation and force the ciliary muscle to continue contracting (Pavel et al., 2023). This can cause an increase in temperature in the front eye chamber which will increase the production of intraocular fluid which can lead to myopia (Pavel et al., 2023).

This research is also in line with other studies which state that different brightness levels also have a great effect on the human eye, when we use low brightness or in brighter areas, our eyes need more accommodation which causes eye strain, which also causes fatigue and headaches (Karouta & Ashby, 2015; Qasim et al., 2021). Misdirected light and very strong lighting cause glare on objects. This glare can cause damage to the eyes which can lead to myopia. According to (Karouta & Ashby, 2015) high light intensity can affect the severity of myopia because it affects the work of the pupil and lens of the eye. To keep the eyes from developing myopia, it is necessary to pay attention to getting good lighting that is not too bright and not too dim.

This study is also in line with other studies which state that the risk of developing myopia is significantly higher among young people who use mobile phones and laptops for longer periods of time and at close range (Singh & ChOudhary, 2023). When reading or using gadgets or laptops, the ideal viewing distance between the eyes and the reading object or screen should be 30 - 40 cm. (Ichhpujani, Singh, Foulsham, Thakur, & Lamba, 2019). If it is less than 30 cm, it will make the eye muscles contract and trigger the enlargement of the eyeball which can cause myopia. The use of gadgets with a close distance makes the ciliary muscle that regulates the lens of the eye will experience chronic spasm which leads to lengthening of the eyeball axis which can cause a person to develop myopia.

In this study, genetics was used as a control because genetic factors (father/mother suffering from myopia) can increase the risk of children suffering from myopia. A child with one parent suffering from myopia will have twice the risk, while if both parents suffer from myopia, the child will have eight times the risk of myopia than a child with parents who do not suffer from myopia (Wulansari, Rahmi, & Nugroho, 2018). Although we were able to control some factors in this study, our study design did not allow us to confirm that the incidence of myopia in students was truly caused by gadget use only during online learning. It is possible that the students were already using gadgets before the online learning started. This cross-sectional study could not measure changes in the duration of gadget use over a period of time. Thus, this is a limitation of our study.

CONCLUSION

This study concluded that there is an association between gadget use (in terms of duration, light intensity, and distance) and the incidence of myopia, even after controlling for genetic factors (father/mother suffering from myopia). The most significant factor associated with the incidence of myopia is the use of gadgets with bright light intensity

which can increase the risk of myopia by 50.058 times. Meanwhile, the position and type of gadget were not associated with the incidence of myopia. Every school should provide eye health promotion by explaining the use of gadgets that are safe or pose a risk of causing myopia.

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