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RELATIONSHIP OF SLEEP QUALITY WITH SHORT-TERM MEMORY AND REACTION TIME IN FIRST-YEAR MEDICAL STUDENTS OF DIPONEGORO UNIVERSITY

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ABSTRACT

Background: Sleep disturbance is a disorder that includes a lack of quantity and quality of sleep. Students, especially medical students, have a high risk of getting sleep disorders of poor sleep quality and quantity. Poor sleep quality can interfere with memory. Poor sleep quality also results in fatigue, which can lead to increased reaction time. **Aim:** To determine the relationship between sleep quality and short-term memory and reaction time in first-year medical students of Diponegoro University. **Methods:** This cross-sectional study observed first-year medical students of Diponegoro University as the subjects. Kolmogorov-Smirnov was applied as distribution test, and the hypothesis test between sleep quality and short-term memory used Pearson Chi-Square test, while sleep quality and reaction time used Mann-Whitney U test. **Results:** Two hundred students participated in the study. Eighty-two people (41%) had good sleep quality, 118 people (59%) had poor sleep quality. The p value of the relationship between sleep quality and short-term memory showed an insignificant result (p=0.791). Meanwhile, the Mann-Whitney test to measure the relationship between sleep quality and reaction time was also insignificant (p=0.270). **Conclusion:** There is no significant relationship between sleep quality with reaction time and short-term memory in first-year medical students of Diponegoro University.
Keywords: *reaction time, sleep quality, short-term memory*

BACKGROUND

The ability to store information as memory is essential for students, both short-term memory and long-term memory. Short-term memory is a memory that lasts from a few seconds to several hours. If short-term memory is repeated continuously, long-term memory will be formed.[1] Memory disorders in the learning process are affected by sleep disturbances. Sleep disturbances not only include a lack of sleep quantity but are also affected by sleep quality. Good sleep quality means that there are no signs of neither sleep disturbances nor sleeping problems.[2]

In addition to good memory skills, speed in responding to a stimulus is also important. The time it takes for a person to respond consciously to a given sensory stimulus is called reaction time. One of the reasons for the slow reaction time is fatigue. This fatigue can be caused by poor sleep quality, among other factors.[4] People with the highest risk of developing sleep disorders are students, especially medical students. Therefore, medical students are prone to have poor quality and quantity of sleep.[5]

This study recruited students from the faculty of medicine of Diponegoro University as the subjects. The measurement of sleep quality was done by using the Pittsburgh sleep quality index (PSQI) scale, short-term memory using the scenery picture memory test (SPMT), and reaction time using the Reaction Time application that can be accessed on mobile phones. It is necessary to observe the relationship between sleep quality, short-term memory, and reaction time to determine whether sleep quality significantly affects short-term memory and reaction time in medical students of Diponegoro University.

METHODS

This observational study used a cross-sectional design. The subjects were first-year medical students of Diponegoro University who meet the inclusion and do not meet exclusion criteria. The inclusion criteria were having a normal vision or corrected refractive error, able to use both hands well, and willing to be a research subject. While the exclusion Criteria were left hand dominant (left-handed), taking anti-depressants and other psychiatric drugs, and total or partial color blindness.

The selection of subjects was carried out using a questionnaire filled out by all medical students of Diponegoro University year 2019. Prospective subjects who met the inclusion and did not meet exclusion criteria were asked to fill out written informed consent. Prospective subjects who

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had signed the informed consent became subjects and data were then collected. The PSQI questionnaire was used for measuring sleep quality, the SPMT was used for measuring short-term memory, and the Reaction Time application was used for measuring reaction time.

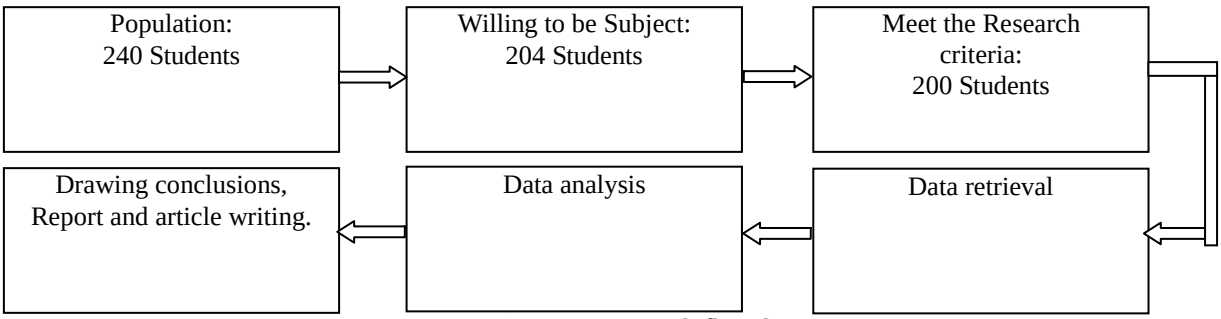

Figure 1. Research flowchart

All procedures of this study gained ethical approval (No. 186/EC/KEPK/FK-UNDIP/IX/2020) from the Medical and Health Research Ethics Commission, Faculty of Medicine, Diponegoro University, Semarang. Privacy of subjects is maintained by not including the identity of the subjects. A non-parametric chi-square test was used for the hypothesis test between sleep quality and short-term memory. The distribution test was conducted first using the Kolmogorov-Smirnov, in which the results were not significant (sig. = 0.000). Then the non-parametric hypothesis test was done by using Mann Whitney U test.

RESULTS

The initial population of the study was 240 students. From a total of 240 students, 204 students were willing to be the subjects. Four people did not meet the requirements so the remaining 200 students were the research subjects.

The characteristics of the subjects can be seen in table 1.

Table 1. Characteristics of subjects.

Characteristics	Sleep quality		p-value
	Good	Poor	
Sex			
Male	32 (16%)	41 (20,5%)	0,536
Female	50 (25%)	77 (38,5%)	
Age			
18	34 (17%)	40 (20%)	0,174
19	33 (16,5%)	62 (31%)	
20	14 (7%)	12 (6%)	
21	1 (0,5%)	4 (2%)	

Table 1 shows that the subjects were 200 students. The subjects were dominated by women, 127 individuals or 63.5%, while men were 73 or 36.5%. The subjects with the age of 18 years were 74 people (37%), 19 years old were 95 people (47.5%), 20 years old were 26 people (13%), and 21 years old were 5 people (2.5%). The p values in the table denoted that there are no significant differences in each sleep quality category between male and female subjects, and among different ages of the subjects.

Relationship between sleep quality and short-term memory

The results of the hypothesis test between sleep quality and short-term memory are shown in table 2.

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Table 2. The results of the hypothesis test of sleep quality on short-term memory.

Characteristics		Sleep Quality		p-value
		Good	Poor	
Short-term memory	Good	63 (31,5%)	9 (4,5%)	0.791
	Poor	89 (44,5%)	11 (5,5%)	

Table 2 showed that the p value is 0.791, which means that there is no significant relationship between sleep quality and short-term memory in first-year medical students of Diponegoro University.

Relationship between sleep quality and reaction time

The results of the hypothesis test between sleep quality and short-term memory are shown in table 3.

Table 3. The results of the hypothesis test of sleep quality on reaction time.

Characteristics (n;%)	Median (milisecond)	Minimum (milisecond)	Maximum (milisecond)	p-value
Good sleep quality (82;41)	257,20	176,60	579,60	0.270
Poor sleep quality (118;59)	250,10	141,00	1933,20	

The median reaction time of the good sleep quality group is 257.20 milliseconds, while of the poor sleep quality is 250.10 milliseconds. The minimum value of reaction time in research subjects with poor sleep quality is 176.60 milliseconds, while the maximum value is 579.60 milliseconds. The minimum value of reaction time in research subjects with poor sleep quality is 141.00 milliseconds, while the maximum value is 1933.20 milliseconds.

The Mann-Whitney test resulted in a p-value of 0.270, this means that there is no significant relationship between sleep quality and reaction time in first-year medical students of Diponegoro University.

DISCUSSION

Relationship between sleep quality and short-term memory

There were 200 students who consented to be recruited into the study. The sleep quality assessed by PSQI questionnaire is not correlated significantly with both short-term memory and reaction time. Based on previous research, many factors can affect short-term memory, including age, psychological conditions, and physical conditions.[6] Several studies have reported that acute stress affects short-term memory in adolescence to young adulthood. Cortisol reactivity to stress and basal memory performance is controlled by the same brain areas, the hippocampus and prefrontal cortex. These two parts of the brain play a role in the feedback regulation of the activity of hypothalamic-pituitary-adrenal (HPA) axis which has many cortisol receptors. The cortisol response to stress has been shown to affect hippocampal volume and glucose metabolism rate in the prefrontal cortex. Simultaneously, the hippocampus and prefrontal cortex control the cortisol response to acute stress and play a role in cognitive processes, including declarative memory and short-term memory.[7]

The p value of 0.791 from the correlation between sleep quality and short-term memory in this study is distant from considered significant and it may demonstrate that there are confounding factors involved. A stressful situation, a situation that is perceived as something that threatens physical or psychological health, can result in cognitive impairment, difficulty concentrating, and organizing thoughts logically. Another study found that repetitive stress can cause dendritic atrophy, suppress hippocampal neurogenesis, and interfere with spatial learning and memory.[8] In addition, differences in stress can also occur in gender differences. This is due to the influence of hormones and stress that causes memory to decrease until finally someone easily forgets.[9] This is in line with the results of research conducted by Abdulghani regarding stress levels in medical students in Saudi Arabia where the prevalence of female students who

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experience stress is 75.7% while there are 57% of male students.[10]

Another psychological condition that can affect this reaction time is anxiety. Anxiety conditions that were not known before this research, resulted in bias in this study. In one study, it was reported that children with attention deficit hyperactivity disorder (ADHD) who experienced anxiety experienced an inhibited response to impulses, causing poor memory performance. The greater a person's anxiety, the greater the cognitive function deficit experienced.[11]

In addition, genetic factors unknown in this study may also affect the results. Genetic variants affect intellectual abilities and also affect human cognition, one of which is memory. Decreased differentiation of neurons in the hippocampus due to epigenetic changes that alter the structure of chromatin and expression of the brain-derived neurotrophic factor (BDNF) gene can result in abnormalities of behavior and cognition, including decreased memory skills and increased anxiety.[12] Another study found that individuals with single nucleotide polymorphism (SNP) rs8027411 in RASGRF1 gene showed better memory performance and higher hippocampal activity.[13]

Iron deficiency in early life (late pregnancy to 2-3 years of age) may also result in memory deficits. Iron deficiency alters the transcriptome¸ metabolism, structure, intracellular signaling pathways, and electrophysiology of the developing hippocampus, where the hippocampus is an important part of the brain that plays an important role in memory.[14] However, although iron deficiency is associated with memory deficits, several studies have shown that iron supplementation shows no memory increase. [15]

Relationship between sleep quality and reaction time

Sleep quality did not significantly affect the reaction time of first-year medical students at Diponegoro University (p= 0.270). Reaction time was measured using a mobile phone application in this study. The statistically insignificant result can be caused by several factors, including different use of mobile phones. Since the study was done online, the results produced have a lot of biases which might be due to differences in the sensitivity level of mobile phone's screen. Another reason for the insignificance of the results of this study is the different physical activities of each student. This difference in physical activity will cause differences in the level of fatigue. Research conducted by Welford states that the reaction time will be longer if the subject is in a state of fatigue. Several experiments have shown that sleep deprivation has little effect on reaction time.[16]

Differences in nutrition and hydration status can affect reaction time as well. Inadequate nutritional intake such as inadequate fluid and electrolyte intake will cause metabolic disorders and fluid imbalance. One study explained that losing 1-2% of body weight due to dehydration can interfere with the cognitive function and body performance of a person that requires attention, memory, and psychomotor. The state of dehydration can indirectly increase the reaction time.[17–19]

Another influential condition is exercise. Exercise can speed up reaction time. This can be observed in athletes and non-athletes where the reaction time of athletes will be faster than non-athletes. For example sprint runners will react faster than non-sprint runners. [17]

CONCLUSION

There is no significant relationship between sleep quality with short-term memory and reaction time in first-year medical students of Diponegoro University.

SUGGESTION

In this study, there are some limitations regarding the research subjects. Future research should recruit more subjects with different ages and characteristics. On the other hand, homogeneous subjects are also suggested to eliminate bias that may arise due to the inhomogeneity of the subjects recruited. Future studies are also expected to be conducted directly so that subjects can be monitored when filling out questionnaires, and during reaction time and short-term memory data collection. Research on other variables is also necessary such as the relationship between sleep quality and long-term memory and stress levels.

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