



## THE ASSOCIATION BETWEEN SLEEP QUALITY AND WORKING MEMORY OF MEDICAL FACULTY MALIKUSSALEH UNIVERSITY STUDENTS

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### ABSTRACT

**Background:** Working memory is a form of storage of information that is relevant to the activity being worked out in a short time and a limited amount of information. The working memory capacity is influenced by sleep quality. Increased human activity in the modern era, causing less attention to the quality and quantity of sleep. Recent study showed that the prevalence of medical student who have poor sleep quality is quite high, reaching 76%. Poor quality of sleep will cause a person to think and work more slowly, make mistakes, and have a hard time remembering things. **Objective:** This research aims to know the relationship of sleep quality with working memory capacity in medical students of Malikussaleh University. **Methods:** This research was an analytical study with cross-sectional approach, and the Fisher test was used as the statistical test. Proportional stratified random sampling was used to obtain 71 samples of students who had qualified inclusion and exclusion criteria. **Results:** The results showed that 84,5% of students had poor quality of sleep and 56,3% of students had low working memory capacity. Statistical analysis by Fisher test showed the value of  $p < 0,05$ . **Conclusion:** there is an association between sleep quality and the capacity of working memory in the Faculty of Medicine students of Malikussaleh University.

**Keywords:** Sleep quality, Working memory capacity, Student

### INTRODUCTION

Sleep is a basic need that must be met by every human being and has an essential role in the continuity of daily activities.<sup>1</sup> Sleep plays a role in homeostatic functions, normal thermoregulation, energy storage, emotional control, and memory consolidation.<sup>2,3</sup> To get enough sleep, one must pay attention to the quantity and quality of sleep. Sleep quality is a condition that a person lives to get freshness and fitness when they wake up from their sleep, while sleep quantity is the number of average hours of sleep that a person needs according to his sleep needs.<sup>4</sup>

In today's modern era, human activities are increasing so that attention to the quality and quantity of sleep is reduced, including medical students. It is reported that 51% of medical students in the United States and 59% in Lithuania have poor sleep quality.<sup>5</sup> Poor sleep quality will lead to physical disorders, psychological disorders, impaired cognitive functioning, and malfunctioning of neurobehavior someone, where one of them is working memory, is slowing. When a person is sleep-deprived, they think and work slowly, makes more mistakes, and has difficulty remembering things.<sup>6</sup>

Working Memory (WM) is a repository of information relevant to the task for a few seconds to

serve the mental activity of other sustainable. Working memory is very limited in the amount of information that can be managed simultaneously in a short period. Impaired working memory causes problems in cognitive and affective processes.<sup>7</sup>

Klingberg showed that problems in attention and learning are often caused by poor working memory. This problem can be seen in people, especially with specific learning disabilities, traumatic brain injury, and ADHD. However, a decrease in working memory capacity can also occur in ordinary people. One of the reasons is due to poor sleep quality. Poor working memory can also affect concentration and academics.<sup>8,9</sup> People with low working memory can less withhold irrelevant information when they are under cognitive load. While people with high working memory are better able to suppress negative and positive emotions than individuals who have low working memory.<sup>10</sup> Sleep behavior affects memory in a state of Rapid Eye Movement (REM) sleep where there is asynchronous activity, sleep-like wakefulness, which is associated with dreams. This sleep state was first called Paradoxical sleep (PS) because it is linked to the cerebral cortex. REM sleep can increase the synthesis of Brain-Derived Neurotrophic Factor (BDNF), an essential regulator



in synaptic transmission and Long Term Potential (LTP) from the hippocampus and other brain regions.<sup>7,11</sup>

Smith, McEvoy, and Gevins reported that after long periods of wakefulness, young adult participants performed worse on accuracy in working memory tasks and reaction time tests than participants who had normal sleep conditions. Sleep deprivation dramatically affects working memory. The researchers explain that even a lack of sleep can impair working memory function and attention.<sup>12</sup> Lack of sleep causes a decrease in metabolic activity in regional brain networks, which is mainly affect information processing and inhibition of reactions.<sup>13,14</sup> Impaired working memory after sleep deprivation related to activation of the default network.<sup>15</sup>

**METHOD**

This study was approved by Ethical Clearance Committee of Medical Faculty, Syiah Kuala University. This analytical study with a cross-sectional approach was held from August 2019 to November 2020. This study used proportional stratified random sampling to obtain 71 samples from 329 students population. The sample were excluded if any of criteria below were met: (1)had any history of mental disorders and/or consumed any psychotropic medication; (2)had history of head injury; (3)consumed alcohol or sedative-hypnotic drugs. The independent variable, sleep quality, was measured using the Sleep Quality Quesioners. Score 25 and above was stand for good quality of sleep and below 25 was stand for poor quality of sleep. Dependent variable, working memory capacity, was measured using the OSPAN test in the form of software from Inquisit. Score above the mean/median value was considered as high working memory capacity, and below or equal the mean/median value was considered as low working memory capacity. The association analysis between both of the variable was tested comparatively using the Fisher test.

**RESULTS**

Characteristics of the respondents showed by table 1. Most of the respondents were female (76,1%).

**Table 1.** Characteristics of Respondents

Gender	Frequency (n)	Percentage (%)
Male	17	23,9%
Female	54	76,1%
Total	71	100%

Table 2 described respondents quality of sleep and table 3 described working memory capacity based on the gender characteristics of the respondents.

**Table 2.** Quality of sleep of the respondents

Quality of sleep	Frequency (n)	Percentage (%)
Poor	60	84,5%
Good	11	15,5%
Total	71	100%

Table 2 showed that most of respondents (84.5%) had poor sleep quality, only 15.5% had good sleep quality.

**Table 3.** Working memory of the respondents

Working memory	Frequency (n)	Percentage (%)
Low	40	56,3%
High	31	43,7%
Total	71	100%

Table 3 showed that out of 71 respondents, 56,3% of respondents had low working memory capacity.

**Table 4.** Working memory based on the gender characteristics of the respondents

Gender	Working memory				Total	
	Low		High		N	%
	N	%	n	%		
Male	8	47%	9	53%	17	100%
Female	32	59%	22	41%	54	100%



Table 4 showed that the working memory capacity of 17 male respondents, of which 47% of them had low working memory capacity and another 53% had high working memory capacity. In comparison, the proportion of working memory capacity owned by 54 female respondents was 59% low and 41% high.

The results of the association analysis between sleep quality and working memory capacity of all respondents can be seen in table 5. The table showed that 63% of respondents with poor sleep quality also have low working memory capacity, and 82% of respondents with good sleep quality also have high working memory capacity.

**Table 5.** Analysis of the association between sleep quality and working memory

Quality of sleep	Working memory				Total		P Value
	Low		High		n	%	
	n	%	n	%			
Poor	38	63%	22	37%	60	100%	0,007
Good	2	18%	9	82%	11	100%	

Fisher's analysis of this data shows a p-value of 0.007, which indicates a significant relationship between sleep quality and working memory capacity.

## DISCUSSION

Table 1,2 and 3 consecutively described that most of the respondents were female, had poor quality of sleep and had poor working memory capacity. The similar pattern were also obtained by Rique et al. and Waqas et al., where poor sleep quality is also experienced by most of medical students in Brazil and Pakistan, 61.5% and 77%, respectively. These results are related to the academic stress experienced by the medical student.<sup>16,17</sup>

Stress, as same as sleep, can affect working memory capacity. Experimentally induced acute stress showed that there was significantly reduced working memory- related activity in dorsolateral prefrontal cortex (DLPFC).<sup>18</sup> This negative effect of the stress modulated by activities-related stress of hypothalamic pituitary adrenal (HPA) axis since large number of glucocorticoid receptors can be found in area related-working memory, such as prefrontal cortex. Consequently, working memory dependent-prefrontal cortex function negatively affected by the increasing of glucocorticoid level

during acute stress.<sup>19</sup> Sleep disorders also been associated to cortisol alteration.<sup>20</sup>

Table 4 showed that the proportion of working memory capacity owned by male and female was not much different, although the working memory capacity (in this case, the verbal working memory capacity) of female is slightly higher than male. This result was similar with the research conducted by Puspasari, where there was a non-significant difference between gender and working memory capacity ( $p > 0.05$ ).<sup>21</sup> Multiple studies have found that eventhough neurofunctional differences may still exist between males and females (males demonstrate greater mathematical, spatial, and object working memory; and females display greater verbal including episodic memory and writing skills), there are no significant performance differences between the genders during verbal working memory tasks. Males and females assumed to be using different psychological strategies to solve the problems.<sup>22,23,24</sup>

Table 5 showed a significant relationship between sleep quality and working memory capacity ( $p$ -value 0.007). Similar results was also reported by Weizhen Xie et al. and Puspasari, which found a relationship between poor sleep quality and decreased working memory.<sup>7,21</sup>

Goel N et al. explained that brain regions involved with executive function and working memory are susceptible to sleep disturbances.<sup>25</sup> Smith et al. also reported that intense sleep deprivation severely affected working memory, that even mild sleep loss interfered with working memory function and attention.<sup>26</sup>

Sleep behavior affects memory in a state of Rapid Eye Movement (REM) sleep. REM sleep can increase the synthesis of Brain-Derived Neurotrophic Factor (BDNF), an essential regulator in synaptic transmission and Long Term Potential (LTP) from the hippocampus and other brain regions, that contributed greatly to the learning process and memory.<sup>7,11</sup> Hippocampus has a main role in consolidate learning and convert information from working memory via electrical signals to long-term storage areas. Hippocampus constantly checks the information conveyed to working memory and compares it with previous experiences.<sup>27</sup> The effect of poor quality of sleep on working memory presumably because the alteration of Brain-Derived Neurotrophic Factor (BDNF) synthesis and also cortisol, that affect hippocampus and other area related-working memory.<sup>7,11,20</sup>



## CONCLUSION

Most of the Medical Students of Malikussaleh University had poor quality of sleep, which was significantly associated with low working memory capacity. The effect of poor quality of sleep on working memory presumably because the alteration of Brain-Derived Neurotrophic Factor (BDNF) synthesis and also cortisol, that affect hippocampus and other area related-working memory.

## ETHICAL APPROVAL

This study was approved by Ethical Clearance Committee of Medical Faculty, Syiah Kuala University, No.264/EA/FK-RSUDZA/2020.

## CONFLICTS OF INTEREST

The authors declare no conflict of interest in this study.

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## AUTHOR CONTRIBUTIONS

Authors contribution to this paper as follows: conceptualization, data collection, and writing original draft preparation: Adilla Afra Amri; analysis and interpretation: Adilla Afra Amri and Rizka Sofia; Supervision and methodology: Cut Khairunnisa; writing-review and editing: Cut Sidrah Nadira

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