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ABSTRACT

A good sleep quality enhances both physiological and psychological functions. Despite the importance of sleep quality, it is one of the common issues faced by the young population due to modern lifestyle. The main purpose of this study is to investigate the effect of sleep quality on cognitive function (working memory and executive function) among Ipoh young adults. A total of thirty-two (n=32) healthy male Ipoh young adults aged (21.0 ± 1.0) years old participated in this study. The sleep quality was measured using Pittsburgh Sleep Quality Index (PQSI). Meanwhile, for cognitive function the N-Back task was used to measure working memory and the Wisconsin Sorting Card Test (WSCT) was used to measure executive function. The results of this study showed a significant effect of sleep quality on working memory (0-Back $p = 0.011$, 1-Back $p = 0.001$, 2 Back $p = 0.008$) and executive function (Category Achievement $p = 0.001$, Total Errors $p = 0.010$). These findings demonstrated sufficient evidence that sleep quality affects cognitive function ($p < .05$). Hence, sleep quality is associated with better cognitive function in young adults.

Keywords: Sleep Quality, Cognitive Function, Working Memory, Executive Function

INTRODUCTION

Sleep is known as one of the fundamental requirements in human health. Sleep is described as a state in which both brain and body regularly repeats for several hours where the sensory system is generally latent, the eyes shut, postural muscles loose and consciousness basically suspended (Buysse et al., 1989). It is also recognized as a predictor of human health related to either physical, mental, wellness and overall vitality (Ohayon et al., 2017). Sleep has a variety of purposes, including supporting growth, learning, and cognitive development, as well as contributing to immunity (Bruce et al., 2017; Ohayon et al., 2017). A good sleep quality provides a number of benefits for both psychological and physiological aspects. One of the benefits is accelerated cardiovascular recovery after psychological stress (Brindle & Conklin, 2012). Besides that, adequate high quality sleep foster's cognitive function related to memory, attention, and concentration (Kato et al., 2018; Monk et al., 1994).

Cognitive function refers to the internal intellectual procedures which underlie how human beings understand, remember, communicate, think, make choices, and remedy issues (Benjafeld, 2019). The cognitive function can be divided into several components such as working memory and executive function (Kato et al., 2018). Working memory permits an individual to retain track of information without forgetting what they were doing (Ma et al., 2020). Short-term memory and long-term memory are two types of working memory (Ma et al., 2020). Short term memory is attributed to temporary electrical activity while long term memory is a process that includes durable changes in the nervous system (Owens et al., 2000). Executive function is defined as a high level of cognitive approaches that enable new ways of functioning and improve an individual's skill in unexpected situations (Gilbert & Burgess, 2008). Organizing, planning, and prioritizing are the analytical application of executive function.

A significant link between sleep and cognitive functioning has been demonstrated over the last decade (Bruce et al., 2017; Kato et al., 2018). Sleep aids in the consolidation of memory and fosters in the development of perceptive and inferential reasoning (Kato et al., 2018). Study by Miller et al., (2014) also stated that sleep is essential for cognitive function as proper sleep is required for mental health and positive mood state. According to Kondo et al., (2021), sleep reawakens memories which strengthens the relation between brain cells. Sleep also enhances creativity which allows the person to increase problem solving abilities and critical thinking (Kondo et al., 2021). Furthermore, sleep can affect reaction time and attention, which are cognitive processes that allow a person to focus on desired stimuli while disregarding other inputs (Dahl et al., 1996).

Despite the positive relation between sleep and cognitive function, the beneficial interaction on working memory and executive function has yet to be clarified. Many researchers conducted studies among children and the older population (Dahl, 1996; Owens et al., 2000; Randazzo et al., 1998). Therefore, it is noteworthy to investigate the same association in the young adult population. Poor sleep quality and sleep deprivation have been reported among young adults due to the modern lifestyle and 24-hour culture of connectivity and media consumption (Ma et al., 2020). The impact of technology usage such as smartphones and tablets especially during bedtime on sleep quality in this population group has captivated researchers' interest. It is important to examine this issue before longer-term consequences develop. Hence,

the primary purpose of this study is to investigate the effect of sleep quality on cognitive function among Ipoh young adults.

METHOD

Subjects

This study involved a total of thirty-two ($n=32$) male young adults in Ipoh aged (21.0 ± 1.0) years old. The inclusion criteria for the potential participant were include; healthy, not under medication and non- smoker. Consent form was obtained from all participants prior to the commencement of the study following detailed explanation of the study description, testing measurement, associated risks, and potential benefits of participation. All procedures were conducted in accordance with the Declaration of Helsinki and ap-proved by the Institution's Ethics Committee. Participants completed all questionnaires through an online medium.

Instrumentation

Sleep Quality

Pittsburgh Sleep Index Quality (PSQI) was used to measure sleep quality. The PSQI contains 19 items in 7 component domains: subjective sleep quality, sleep duration, habitual sleep efficiency, sleep latency, sleep disturbances, use of sleep medication, and daytime dysfunction. The component scores are added together to yield a global sleep quality score that ranges from 0 to 27. Participants who had a score of 6 or higher were regarded to be poor sleepers. The reliability of PSQI is $r = 0.87$.

Cognitive function

Participants were required to complete the N-Back task to measure working memory. The N-Back task is a computer software task which requires the participants to update their mental set continually while reacting to previous stimulus numbers (0-Back, 1-Back and 2-Back conditions). Participants were required to monitor a series of numerical stimuli and identify when the presented number was the same as the previously presented number.

The Wisconsin Sorting Card Test (WSCT) was used to measure executive functions such as the ability to change cognitive strategies in a changing environment. It consists of stimulus and response cards. The participants were required to accurately sort every response card with one of four stimulus cards through the feedback (right or wrong) given to them. Two measurements were obtained from this test; Category achievement and Total error. Category achievement is the number of categories for correct responses while total error is the sum of error scores.

Statistical Analysis

Statistical analysis was carried out using Statistical Packaging for Social Sciences (SPSS) Statistics version 24. Regression analysis was used to examine the effect of sleep quality on cognitive performance. Statistical significance level was accepted at $p < 0.05$.

RESULT

Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. Table 1 presents the mean \pm SD value of respondent's characteristics. The result of regression analysis showed a significant effect of sleep quality on working memory (0-Back $p = 0.011$, 1-Back $p = 0.001$, 2 Back $p = 0.008$) (Table 2) and executive function (Category Achievement $p = 0.001$, Total Errors $p = 0.010$) (Table 3).

Table 1. Participants Characteristics

	Mean \pm SD
Age	21.0 \pm 1.0
PSQI	8.5 \pm 4.3
N-Back task	
0-Back	81.9 \pm 11.0
1-Back	75.8 \pm 13.7
2-Back	67.2 \pm 11.6
WSCT	
Category Achievement	5.2 \pm 2.2
Total Error	4.1 \pm 4.0

Table 2. Effect of Sleep Quality on Working Memory

	Sleep Quality	
	β	<i>p</i>
0-Back task	0.172	0.011
1-Back task	0.275	0.001
2-Back task	0.187	0.008

Predictor (Constant): PSQI

Dependent variable: Working Memory (0-Back, 1-Back, 2-Back task)

Table 3. Effect of Sleep Quality on Executive Function

	Sleep Quality	
	β	p
Category achievement	0.281	0.001
Total error	0.173	0.010

Predictor (Constant): PSQI

Dependent variable: Category achievement, Total error

DISCUSSIONS

In the present study, sleep quality was significantly associated with cognitive function reflected by the results of working memory and executive function. All the subcomponents of working memory (0-Back, 1-Back, 2-Back) and executive function (Category achievement, Total error) reported $p < 0.05$. These findings demonstrated sufficient evidence that sleep quality has influences on cognitive function performance.

The result of this study broadly supports the work of other studies in this area that link sleep quality and working memory. A study done by Bruce et al., (2017) found that the N-back tasks performance was affected by sleep quality due to the increase in mental demand caused by the task load increment from 1-Back to the 2-back condition. (Kato et al., 2018) also showed a similar result with the present study which mentioned that sleep quality was not associated with executive function but associated with working memory. In a study conducted by Ma et al., (2020) reported that subjects have impairment in working memory due to the total sleep deprivation. In addition, Pedone et al., (2005) found that subjects suffer decline in quality of information stored in memory as the result of 36 hours of sleep deprivation. The result from this study also seems to be consistent with the findings by Ma et al., (2020) who reported an inverted U-shaped association between sleep duration and cognitive function. Insufficient sleep duration (less than 4 hours per night) led to cognitive decline.

Another study done by Ye et al., (2021) revealed a significant relationship between sleep quality and executive function. In this study, the researcher indicates that total sleep time is important for the young adult as the young adults from the study suffer decline in executive function performance, but older adults do not impair in executive function performance even though they suffer the decline in sleep duration. Ma et al., (2020) stated that the decline of executive function performance is influenced by the lack of sleep efficiency. The results from this study are contrary to several previous studies that indicate that sleep quality and duration does not influence executive function. A study conducted by Owens et al., (2000) found that sleep quality does not impair executive function. This study which involved 61 participants indicates that one night of sleep deprivation (34-36 hours) does not decline the performance of Wisconsin Sorting Card Test (WSCT).

CONCLUSIONS

Sleep quality was significantly associated with working memory and executive function. Our findings suggest that sleep has an important role in constructing optimal cognitive performance which is critically important for young adults. Therefore, it is important to maintain good sleep quality by practicing good sleep habits and hygiene. Improved awareness of sleep importance can help to identify and manage problems before longer-term consequences develop.

Conflict of Interest

Syed Murshid Syed Zubir, Sharifah Maimunah Syed Mud Puad, Nurul Ain Abu Kassim and Yusandra Md Yusoff declare that they have no conflict of interest.

Author's Contribution

Syed Murshid Syed Zubir carried out this study and drafted the manuscript, Sharifah Maimunah Syed Mud Puad participated in the design of the study and wrote the manuscript, Nurul Ain Abu Kassim performed the data analysis and participated in the design of the study, Yusandra Md Yusoff reviewed manuscript. All authors read and approved the final manuscript.

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