SLEEP MEDICINE BOOK

Sleep Medicine:
Multidiscipline in Harmony

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The Effect of Sleep Deprivation after Night Shift on Attention Function Measured Using *Psychomotor Vigilance Task* (PVT) on Health Workers at Dr. Wahidin Sudirohusodo Hospital

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ABSTRACT

Background: Sleep is one of the functions of life. How the process that occurs during sleep is still being studied. Currently, it is known that various disorders in the medical field can affect sleep function and disturbances in sleep patterns themselves can affect the quality of human life, including one that affects the function of attention. Attention is needed in order to maintain the quality of work of health workers in providing health services. Deprivation of sleep duration can affect this. Psychomotor Vigilance Task (PVT) is a method that can be used to measure the level of attention. The goal of this research is to determine the effect of sleep deprivation on the function of attention

Methods: An experimental analytical study on 28 samples of health workers who served in Dr. Wahidin Sudirohusodo Hospital with consecutive sampling method, July-August 2021. The sample was given a questionnaire to determine sleep duration and personal data. After filling out the questionnaire, the sample was given a test to determine the level of attention. Measurement of attention level using Psychomotor Vigilance Task (PVT) software which was carried out for 5 minutes. The results of the examination are presented in tabular form and the data were statistically analyzed with the Wilcoxon test and the Spearmen correlation test.

Results: There is a correlation between sleep duration with reaction time and lapses, the p value of reaction time (0.003) < 0.05 with a correlation strength of -0.541, and the p value of lapses (0,011) < 0,05 with a correlation strength of -0,476.

Discussion: Sleep deprivation has been proven to cause a decrease in the function of attention, so this will have an impact on a decrease in individual performance, especially health workers. This study was conducted to determine the effect of sleep deprivation on the function of attention, considering that health workers who had been on night shift were vulnerable to sleep deprivation and require adequate attentional functions to remain excellent in providing health services. In this study, the function of attention of health workers who experience a deprivation in sleep duration after night shift shows to be decreased. These results are consistent with previous studies that sleep duration greatly affects the function of attention

Conclusion: There is a decrease in the function of attention in health workers who experience a deprivation in sleep duration after night shift.

Keywords: Attention, Sleep Deprivation, PVT.

BACKGROUND

Sleep is one of the functions of life. How the process that occurs during sleep is still being studied. Currently, it is known that various disorders in the medical field can affect sleep function and disturbances in sleep patterns themselves can affect the quality of human life and even interfere with health and can be life-threatening. During sleep, fluctuating and dynamic changes occur in the nervous, cardio-respiratory and metabolic systems.[1] The function of sleep in general is for restorative function, maintaining homeostasis, thermoregulation, and maintaining sustained attention. This function will be obtained if a person fulfills his sleep needs. Sleep requirements change dramatically from infancy to old age. Newborns have a polyphasic sleep pattern, with 16 h of sleep per day. This sleep requirement decreases to approximately 10 h per day by 3–5 years of age. In preschool children, sleep assumes a biphasic pattern. Adults exhibit a monophasic sleep pattern, with an average duration from 7.5 to 8 h per night. This returns to a biphasic pattern in old age.[2]

A sleep-deprived person tends to take longer to respond to stimuli, particularly when tasks are monotonous and low in cognitive demands. However, sleep deprivation produces more than just decreased alertness.[3] Sleep deprivation and sleepiness because of lifestyle and habits of going to sleep and waking up at irregular hours can be considered to result from disruption of the normal circadian and homeostatic physiology.[2] Tasks requiring higher cognitive functions, such as logical reasoning, encoding, decoding and parsing complex sentences; complex subtraction tasks, and tasks requiring divergent thinking, such as those involving the ability to focus on a large number of goals simultaneously, are all significantly affected even after one single night of sleep deprivation. Tasks requiring sustained attention, such as those including goal-directed activities, can also be impaired by even a few hours of sleep loss. Thus, sleep loss causes attention deficits, decreases in short-term memory, speech impairments, perseveration, and inflexible thinking. These deficits can explain why sleep-deprived subjects underestimate the severity of their cognitive impairment, often with tragic consequences. Another reason people may underestimate their impairment due to sleep loss is that the lack of sleep does not completely eliminate the capacity to perform but rather makes the performance inconsistent and unreliable. Thus, a sleepy driver will either respond normally to an emergency or not at all, due to rapid changes in vigilance state and the sudden intrusion of microsleeps during waking. Similarly, subjects may still be able to transiently perform at baseline levels in short tests even after 3 to 4 days of sleep deprivation. However, the same subjects will perform very poorly when engaged in tasks requiring sustained attention. New evidence suggests that not just a few hours of sleep but several days of normal sleep–wake patterns are required to normalize cognitive performance after sleep deprivation.[3]

Cognitive impairment is unfortunately not only the consequence of total sleep deprivation. Cognitive performance is also affected by sleep restriction (6 hours per night or less) if it continues for several days and by chronic sleep discontinuity such as that occurring in patients with chronic pain, sleep apnea, or other sleep disorders. According to the 2002 "Sleep in America" poll conducted by the National Sleep Foundation, United States residents of at least 18 years of age slept on average 6.9 hours during the weekdays and 7.5 hours on weekends. Twenty-four percent of the respondents in this poll reported that during weekdays they sleep less than they needed to in order to avoid feeling sleepy the next day. Whether this chronic sleep restriction is sufficient to affect objective measures of cognitive performance is not known, but it is certainly concerning given the data from sleep restriction studies that point to impairment and decreased performance.[3]

Brain and peripheral tissues respond differently to sleep loss. Like in sleep-eprived animals, the peripheral metabolic rate is increased in sleepdeprived human subjects and in normal sleepers on nights of poor sleep relative to baseline nights; this increased rate is lso present generally in people with insomnia relative to normal sleepers. In both animals and humans, glucose metabolism is higher in many brain regions in waking than that in NREM sleep. After 1 day of sleep deprivation, selective brain areas can still be activated metabolically when the subject is engaged in specific tasks. However, the global cerebral metabolic rate does not increase and actually decreases relative to normal waking values in areas such as the thalamus and the midbrain. Thus, while peripheral metabolic rate is persistently increased during sleep deprivation, brain metabolic rate is not. This may be an indication that the brain cannot sustain high-energy metabolism for too long.[3]

A survey study found that, compared with the population at the turn of the century (1910–1911), American adolescents aged 8–17 years in 1963 were sleeping 1.5 h less per 24-h period. This does not mean we need less sleep today but that people are sleep deprived. A study by Bliwise et al. in healthy adults aged 50–65 years showed a reduction of about 1 h of sleep per 24 h between 1959 and 1980 surveys. Factors that have been suggested to be responsible for this reduction of total sleep include environmental and cultural changes, such as increased environmental light, increased industrialization, growing numbers of people doing shift work, and the advent of television and radio. A review of the epidemiologic study by Partinen estimated a prevalence of excessive sleepiness in Westerners at an average of 5–15 % of the total population. In contrast, Harrison and Horne argued that most people are not chronically sleep deprived but simply choose not to sleep as much as they could. These studies have conclusively proved that sleep deprivation causes sleepiness; decrement of performance, vigilance, attention, and concentration; and increased reaction time.[2]

The psychomotor vigilance task (PVT) is considered the gold standard for detecting fatigue in laboratory and field, studies due to its documented sensitivity in detecting sleepiness.[4] The PVT is characterized by extended periods of vigilance and anticipation between brief response-evoking stimuli. A temporally-resolved assessment of not only evoked network response, but also pre-stimulus activity, could provide insight to explain performance and the impact of sleep disruption.[5] The original form of the PVT (PVT-192) is a handheld test with a 3-mm display that delivers a visual stimulus in the form of a reaction-time counter, presented with an interstimulus interval varying between 2 and 10 s. Participants are instructed to rest their thumbs on two physical buttons and depress one button with their dominant thumb as quickly as possible as soon as the stimulus appears. If participants press the button too soon, the phrase "false start" appears on the display. The total task duration for each PVT trial is 10 min.[4] This simple measure of reaction time (RT) to repetitive stimuli has become recognized as a highly effective tool for measuring degradation of sustained attention performance under sleep deprivation. Adult experiments have shown that sleep deprivation results in increased average reaction times, errors of commission, and frequency of especially long reaction times (>500 ms) known as lapses. A smaller literature confirms similar effects in adolescents.[5]

The PVT has no significant learning curve, making this task ideal for evaluating fatigue arising from sleepiness and circadian misalignment in field settings. With the rapid development of new mobile technologies, several versions of the PVT have been developed for handheld devices. The portability of mobile devices provides a desirable medium for assessment of fatigue in remote settings; however, there are many methodological considerations related to administration of a PVT on a handheld touch screen device that remain unresolved. The most widely used handheld version of the PVT is a 5-min test that was developed for use on Palm OS and validated against the PVT-192; however, that version of the PVT utilized a physical button to register RT. In contrast, implementation of the PVT on touch screen devices requires participants to hover their fingers over the screen. Recent evidence suggests that under carefully controlled laboratory conditions, touch screen versions of the PVT yield changes in RT consistent with those recorded by computer versions of the test. In addition, the RT registered following a finger deflection on a touch screen is similar to that obtained with a physical button press. It is not clear, however, whether the orientation that one uses to hold a device affects RT. It is also not clear whether the finger that a participant uses to respond to a test stimulus alters the recorded RT. Given the limited information available regarding how the orientation of a touch screen device may affect RT, we aimed to compare RTs of participants with the device in portrait and landscape positions, using the index finger or the thumb to respond to the stimuli. Second, we aimed to identify the device latency between the actual time of a touch and the RT recorded by a commonly used touch screen device in order to adjust the PVT trials before analyses.[4]

In this study using PC-PVT 2.0 software. The PC-PVT 2.0 operating system for Windows 10 provides individual inhibiting PVT predictions in real time for each sleep deprivation state.[6]

Deprivation of sleep has been proven to cause a decrease in attention function, so this will have an impact on a decrease in individual performance, especially health workers. For this reason, this study was conducted to determine the effect of sleep deprivation or reduced sleep time after night service on the attention function of health workers at Dr. Wahidin Sudirohusodo, considering that health workers who have been on night duty are prone to sleep deprivation and need good attention functions to remain excellent in providing services.

METHODS

Research Design

This research is an experimental analytical research. The research design used in this study was a single-blind clinical trial with randomization.

Place and Time of Research

Data collection was carried out at dr. Wahidin Sudirohusodo Makassar. The time of the research was carried out from July 2021 to August 2021.

Research Population

The population of this study were all health workers at RSUP Dr. Wahidin Sudirohusodo who performs night service in July-August 2021.

Research Sample and Sampling Method

The research sample was all the study population that met the inclusion and exclusion criteria who followed the study to completion. The sample was obtained by consecutive random sampling method, which took health workers who met the inclusion and exclusion criteria until the number of samples was met.

Inclusion and Exclusion Criteria

The inclusion criteria used are as follows:

1. Health workers aged 18-58 years, both male and female.
2. Health workers who are scheduled for night shift.
3. Health workers who were sampled experienced a reduction in sleep during night shift.
4. The sample stated that it did not mind being included in the study by signing a statement of consent.

Subjects are excluded from the study if:

1. Experience a reduction in sleep duration before night shift.
2. No reduction in sleep duration after night shift.

3. Having trouble concentrating
4. Have had sleep disturbances before
5. Taking sedative or hypnotic drugs (benzodiazepines, antidepressants, etc.)

The independent variable in this study was sleep deprivation. The dependent variable is the function of attention. The confounding variables were sleep disturbance, sedative drug consumption, caffeine consumption, and alcohol consumption. The sample size required for two-sided testing is obtained by the formula (Lemeshow, 1998) as follows:

$$n = \frac{\sigma^2(Z_{1-\alpha/2} + Z_{1-\beta})^2}{(\mu_0 - \mu_a)^2}$$

$$n = \frac{8.46^2(1.28 + 0.84)^2}{(23.1 - 19.7)^2}$$

$$n = 28$$

Information
n=*Sampel*
σ=*Standar Deviasi*
α=*Tingkat Kepercayaan* (90%)
β=*Kekuatan Sampel* (90%)
$\mu 0$=*mean CRP pada kelompok kontrol*
μa=*mean CRP pada kelompok OSA*

Based on research results of Paul Whitney, et al (2017) :
The type I error (α) used is 0.20 or 20% with the direction of the type I error (α) in two directions (two-sided) so that the Z value is 1.28
Type II error (α) used is 0.20 or 80% with the direction of type I error (β) in one direction (one sided) so that the Z value is 0.84
The mean value used is the new cue d' value in the case group of 23.1 and 19.7 in the control group.
Based on the minimum number of samples obtained by 28 samples.

RESULTS

This research was conducted at dr. Wahidin Sudirohusodo Makassar which took place from July 2021 to August 2019. From the research conducted from July 2021 to August 2021, the number of samples collected and meeting the inclusion criteria was 28 people. The characteristics of the sample based on gender and age, showing that in the treatment group the number of samples was 13 men (46.4%) and 15 women (53.6%) with a mean age of 30.14. From the analysis, the results showed that sleep duration decreased from 7.46 to 4.14 after the intervention, the statistical test results obtained p value (0.000) < 0.05. The reaction time increased from 520.93 to 806.07 with statistical test results obtained p value (0.000) < 0.05. That there is a correlation between sleep duration and reaction time because the p value (0.003) < 0.05 with a correlation strength of -0.541 which is in the category of strong correlation with a negative direction (the higher the sleep duration, the lower the reaction time, and the lower the sleep duration, the higher the reaction time).

DISCUSSION

This study assessed the effect of sleep deprivation on decreased attentional function. Attention function was assessed before the night shift sample with normal sleep duration, then reassessed after the night shift sample with reduced sleep duration. This attentional function was measured using the Psychomotor Vigilance Task (PVT) software, by assessing the reaction time generated during the test.

This study collected 28 samples of health workers who met the inclusion criteria. Differences in sleep duration and reaction time before and after night shift showed significant results. In the sleep duration, the score decreased from 7.46 to 4.14 after night shift, the statistical test results obtained a p value (0.000) < 0.05. The reaction time increased from 520.93 to 806.07. There is a correlation between sleep duration and reaction time because the p value (0.003) < 0.05 with a correlation strength of -0.541 which is in the category of strong correlation with a negative direction (the higher the sleep duration, the lower the reaction time or vice versa). The lapses value increased from 20,86 to 33,75. There is a correlation between sleep duration and lapses because the p value (0.011) < 0.05 with a correlation strength of -0,476 which is in the category of strong correlation with a negative direction (the higher the sleep duration, the lower the lapses or vice versa).

limitation in this study is that the assessment of attentional function only uses PVT software. This cannot be used as the only test tool because the PVT output is influenced by individual differences and individual motivations. This PVT software also has an average delay that affects the speed of the resulting reaction.

CONCLUSION

The results of the analysis showed a significant relationship between sleep duration with reaction time and lapses. The results of reaction time and lapses have a negative correlation with sleep duration, where the less duration of sleep, the score of reaction time and lapses will increase, which indicates a slowdown in response time.

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The researcher would like to thank all participants and all parties who have contributed to this research.

TABLES

Table 1. Demographic Characteristics of Research Subjects (N = 28)

Characteristics		n	%	mean	SD
Gender	Man	13	46.4		
	Woman	15	53.6		
Age				30,14	3.55
Total		28	100.00		

Table 2. Average value of sleep duration, reaction time, and lapses before (pre) and after (post) night shift. (Wilcoxon Test Analysis Result)

Variable	Pre		Post		p Value
	Mean	SD	Mean	SD	
Sleep Duration	7,46	0,69	4,14	1,46	0,000
Reaction Time	520,93	135,44	806,07	262,74	0,000
Lapses	20,86	13,12	33,75	12,67	0,000

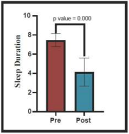
* Wilcoxon Test

Table 3. Correlation between sleep duration with reaction time and lapses. (Spearman Correlation Test Analysis Result)

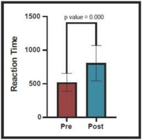
Variable	Sleep Duration	
	r value	P value
Reaction Time	-0,541	0,003
Lapses	-0,476	0,011

*Spearmen Correlation Test

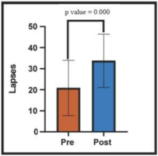
Graphics 1. Comparison of Sleep Duration Before (Pre) and After (Post) Night Shift



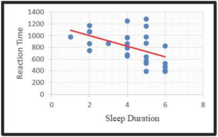
Graphics 2. Comparison of Reaction Time Before (Pre) and After (Post) Night Shift



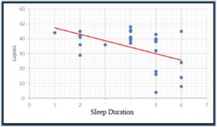
Graphics 3. Comparison of Lapses Before (Pre) and After (Post) Night Shift



Graphics 4. Correlation between sleep duration and reaction time.



Graphics 5. Correlation between sleep duration and lapses.



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