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The Effect of Partial Sleep Deprivation in Decrease of Cognitive Function in Resident Doctors of Udayana University/Sanglah General Hospital

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Abstract: ***Background: Resident doctors often experience sleep deprivation due to their night shift duty. In some studies, the night shift duty was correlated with decrease of professional performance, in term of cognitive function and ability. Purpose: To find the effect of partial sleep deprivation in decreased cognitive function in resident doctors of Medical Faculty of Udayana University/Sanglah General Hospital Denpasar. Method: This is an analytic observational prospective cohort conducted in Sanglah General Hospital Denpasar from December 2016 to January 2017, in 88 subjects (44 subjects with partial sleep deprivation and 44 subjects with no sleep deprivation). The measurement of sleep deprivation was taken using ESS, prior to night shift duty and right after night shift duty. Decreased cognitive function was defined as decrease of MoCA-INA score before and after night shift duty. Bivariate analysis was done using mann-whitney U test due to abnormal data distribution. Results: the median of decreased cognitive function score between the partial sleep deprivation and the control group differed significantly, and significantly correlated with decreased cognitive function (median (min-max) 5 (2-11), p<0.001). Conclusion: Partial sleep deprivation significantly correlated with decreased cognitive function in resident doctors of Udayana University/Sanglah General Hospital.***

Keywords: partial sleep deprivation, decreased cognitive function

1. Background

Sleeping is a vital process in human life. The quality of sleep plays important part in cognitive function. Sleeping is a normal state that comes from the change of alertness and response to stimuli. Inadequate and poor quality sleep disturbs the normal physiological and psychological state.[1]This includes decrease of daily activity, fatigue, neuromuscular problems, decrease of immunity, stress, anxiety, and cognitive problem.[2]

Sleep deprivation is one sleeping problem that has less attention. Sleep deprivation occurs when one fails to meet the adequate amount of sleep. Inadequate sleep is one of complex problems faced by society, which includes inadequate sleeping hours, low quality and low consistency. One measuring tool used to detect sleep deprivation is *The Epworth Sleepiness Scale* (ESS). It subjectively measures the quantity of sleep and divides the result into either adequate sleep or sleep deprivation.[4] Resident doctors have abundant workloads which often require long working hour which leads to sleep deprivation, all the while demanded to give the best in public health service. A meta-analysis showed that sleep deprivation less than 30 hours caused a significant reduction in clinical performance in resident doctors and other medical personnel.[4,5] The research showed sleepiness, poor lipid profile, change in Complete Blood Count, and poor professional performance, especially from the perspective of cognitive function and skill, after a night shift duty.[6]

Sleep deprivation is assumed to have a general effect on alertness and attention, or a selective effect on certain brain structure and function. In a lapse hypothesis, decrease of cognitive function is mediated by low attention and decreased alertness which then causes slow response and unstable awake state. Attention fault, a short period of inattentiveness, has been thought to be the main reason behind decrease cognitive function in sleep deprivation. Decreased performance will be shown during long, simple, and monotone simulation that needs swift response or attention.[6,8] The prefrontal vulnerability hypothesis by Horne, postulated that sleep deprivation disrupt the function of certain parts of the brain which results in low cognitive performance.In sleep deprivation, the cortisol level is increased, as response to the low melatonin level. Cortisol can penetrate the blood brain barrier easily and bind to the receptors in prefrontal area that plays part in attention, perception, learning, and memory. Study by Comijs found that high cortisol level was related to poor memory and information processing. High cortisol level was also found to be related to poor cognitive function in research by Lea.In addition, there is increase of IL-6 level as an inflammation response, an effect synergistic with cortisol, which suppresses orexyn secretion that affects the alertness and concentration in sleep deprivation.[9-14]

MoCA(*Montreal Cognitive Assessment*) is a questioner to evaluate the global cognitive function that includes executive function and memory. MoCA is especially ideal to evaluate frontal lobe. It has high sensitivity (0.94) and moderate specificity (0.42). thus, a positive screening result by MoCA needs further comprehensive neuropsychology test.[15]MoCA has *α Cronbach*value of 0.78 and as such, a reliable questioner to detect and early diagnose cognitive function disturbance in varying age and level of education. MoCA has total score of 30 with 26 as cut-off for cognitive problem.

This study was aimed to find the effect of partial sleep deprivation in decreased cognitive function in the resident doctors of Udayana University-Sanglah General Hospital Denpasar.

2. Purpose of Study

To find the effect of partial sleep deprivation in decreased cognitive function in the resident doctors of Udayana University-Sanglah General Hospital Denpasar.

3. Method

This study was a observational-analytic prospective cohort with two groups: subjects with partial sleep deprivation and subjects without sleep deprivation. The study was conducted in Neurology department of Udayana University Medical Faculty/Sanglah General Hospital, from December 2016 to February 2017. All EES and MoCA INA tests done in Sanglah General Hospital Denpasar.

Sample was taken from resident doctors fulfilling night shift duty in Sanglah General Hospital who matched inclusion criteria. The inclusion criteria were:

1) All resident doctors currently taking residency in University Medical Faculty/Sanglah General Hospital.
2) Still actively involved in residency program.
3) Taking night shift duty.
4) Subjects with risk factors, evaluated during night shift duty.
5) Subjects in control group evaluated during working hours (day shift).
6) Fill in and sign in the consent form.
7) Resident doctors of red, yellow, and green badge levels.
8) The exclusion criteria were:
9) History of sleeping problem.
10) Resident doctors of Neurology, Psychiatry, and Pathology Anatomy department.
11) History of cognitive problem.
12) On sleeping tablets, anti-depressants, or anti-anxiety agents.
13) History of anxiety, depression, and pain probem.
14) History of chronic disease.
15) History of surgery 2 weeks prior to participation.
16) On pregnancy or in 3 months post partum period.

Based from calculation, minimal sample required was 40 subjects each group, with 10% drop out estimation, thus total sample required was 88. Sampling was taken by random cluster method. Subjects matched the inclusion and exclusion criteria was tested with ESS and given another test in the following 24 hours. The cognitive function was measured using MoCA-INA at the same time as sleep deprivation measurement, and repeated again in the following 24 hours in Sanglah General Hospital. Decreased cognitive function was described as lowering of MoCA-INA score. Partial sleep deprivation acted as independent variable, while age, amount of sleep (in hours), study program, level of residency, coffee consumption, marital status and children acted as dependent variables. Sleeping problem, depression, anxiety, hypertension, diabetes, stimulants, smoking, and alcohol consumption acted as bias. All data analysis was done using SPPS ver.20 for Windows.

4. Results

All 88 subjects were divided into two groups. The characteristics shown in Table 1.

Table 1: Subject Characteristics

Variable	Partial Sleep Deprivation	No Sleep Deprivation	*P*
	N (%)	N (%)	
Age(years)			
Median (min - max)	29(25-36)	29 (26-38)	<0,001
Sex			
Male	24 (54,5)	20 (45,5)	0,394
Female	20 (45,5)	24 (54,5)	
Marital Status			
Married	25 (56,8)	26 (59,1)	0,829
Single	19 (43,2)	18 (40,9)	
Duration in sleep in 24 hours	44 (100)	7 (15,9)	<0,001
< 7 hours	0 (0)	37 (84,1)	
≥7 hours			
Residency Program			
Pediatry	5 (11,4)	5 (11,4)	<0,001
Internal Medicine	5 (11,4)	5 (11,4)	
Cardiology	5 (11,4)	5 (11,4)	
General Surgery	5 (11,4)	5 (11,4)	
Orthopedic and Traumatology	5 (11,4)	5 (11,4)	
Obstetric and Ginecology	5 (11,4)	5 (11,4)	
ENT-Neck Ophthalmology	4 (9,1)	4 (9,1)	
Anesthesiology and Intensive Care	5 (11,4)	5 (11,4)	
Level of Residency			
Red Badge	16 (36,4)	18 (40,9)	0,248
Yellow Badge	9 (20,5)	14 (31,8)	
Green Badge	19 (43,2)	12 (27,3)	
Parental Status			
Yes	23 (52,3)	29 (65,9)	0,193
No	21 (47,7)	15 (34,1)	
Coffee Consumption			
Yes	12 (27,3)	13 (29,5)	0,813
No	32 (72,7)	31 (70,5)	

The data had abnormal distribution (p<0.001), had median age of 29 with minimum age of 25 and maximum age of 36.

Table 2: Bivariate Analysis of Partial Sleep Deprivation and Decrease of Cognitive Function

		MoCA-INA score (starting point)	MoCA-INAscore (end point)	Decrease of cognitive function	
			Median (Minimum-Maximum)		*P*
Partial Sleep Deprivation	Yes	29 (27-30)	24 (16-28)	5 (2-11)	< 0,001
	No	28 (26-30)	29 (27-30)	-0,5 (-2-1)	

As shown in table 2, mann-whitney U test was used for the data distribution was abnormal (p<0.001). The *p* value was decided as <0.05. The median score of decreased cognitive function in the partial sleep deprivation group was 5, with minimum score of 2 and maximum of 11, respectively. The median in the control group was -0.5, with minimum score of -2 and maximum of 1. Based on this, we found that the

partial sleep deprivation was significantly related with decreased cognitive function (p<0.001).

In table 3, the relations between each dependent factors were tested using mann-whitney U test. We found sex (p=0.494); marital status (p=0.942), parental status (p=0.062) and coffee consumption (p=0.266) were statistically insignificant. As for age, since the data was abnormally distributed, Kruskal-Wallis test was used, and we found no statistical significance between age and decreased cognitive function (p<0.001).

In Table 4, multivariate analysis was done in variables that had *p*-value <0.25 in the bivariate analysis. This were subsequently continued with linear regression test. We found that partial sleep deprivation was an independent risk factor in decreased cognitive function.

Table 3: Bivariate Analysison Other Variables and Decrease of Cognitive Function

	Decrease of Cognitive Function Median (Minimum-Maximum)	*P*
Age	29 (25-38)	0,495*
Sex		
Male	2 (-2-11)	0,494
Female	0,5 (-2-10)	
Marital Status		
Yes	1 (-2-11)	0,942
No	2 (-2-10)	
Parental Status		
Yes	0,5 (-2-10)	0,062
No	4 (-2-11)	
Residency Program		
Pediatry	1,5 (-1-10)	0,061*
Internal Medicine	1,5 (-2-7)	
Cardiology	2 (0-7)	
General Surgery	2 (-1-6)	
Orthopedic and Traumatology	1 (-1-7)	
Obstetric and Gynecology	1,5 (-1-11)	
ENT-Neck	2 (-2-6)	
Ophthalmology	1,5 (-2-6)	
Anesthesiology and Intensive Care	1 (-1-6)	
Level of Residency		
Red Badge	0,5 (-2-11)	0,091*
Yellow Badge	0 (-2-6)	
Green Badge	4 (-2-7)	
Coffee Consumption		
Yes	0 (-1-7)	0,266
No	2 (-2-11)	
Duration of sleep in 24 hours		
< 7 hours	4 (-1-11)	
≥ 7 hours	-1 (-2-1)	<0,001

**kruskal-wallis test*

Table 4: Independent Risk Factorsin Decrease of Cognitive Function

	Variable	*R*	*P*
Step 1	Parental status (with children)	0,088	0,147
	Residency program	-0,039	0,459
	Level of Residency	0,007	0,899
	Duration of sleep in 24 hrs	0,005	0,962
	Sleep Deprivation	-0,871	<0,001*
Step 2	Parental status (with children)	0,087	0,102
	Residency program	-0,039	0,451
	Level of Residency	0,007	0,898
	Sleep Deprivation	-0,866	<0,001*
Step 3	Parental status (with children)	0,088	0,093
	Residency program	-0,040	0,444
	Sleep Deprivation	-0,867	<0,001*
Step 4	Parental status (with children)	0,095	0,066
	Sleep Deprivation	-0,866	<0,001*

5. Discussion

Decreased cognitive function in this study was defined as the lowering of MoCA-INA score after a repeated test. In table 2, the median (min-max) of decreased cognitive function score was 5 (2-11) in the partial sleep deprivation group, and -0.5 (-2-1) in control group. In bivariate analysis using mann-whitney U test, we found that partial sleep deprivation was statistically significant in relation with decreased cognitive function.

The results matched the prior studies, such as one by Durmer and Dinges that stated that cognitive function and mood were more affected by partial sleep deprivation rather than total sleep deprivation.[8] Meta-analysis by Philibert and Alhola showed that sleep deprivation less than 30 hours caused significant decrease of performance in resident doctors and other medical personnel.[5,6]Pikovsky et al. found that after night shift duty, there were increased sleepiness, fatigue, poor lipid profile, change in Complete Blood Count, and decreased cognitive function in resident doctors.[7] Study by Kim JH et al. in which resident doctors with sleep deprivation were found to be correlated with low attention and difficulty in learning (p<0.05).[16] Study by Suozzo et al. found that post-night shift resident doctors had lower cognitive function compared to those not on shift.[17]

This is also in correlation with the theory that sleeping is an active, repetitive, and reversible process needed for various functions such as growth, memory consolidation, and restorative process. Behavioral, physiological, and neurocognitive process are involved in sleeping process, just as immune system is.[18] Sleep deprivation is assumed to have general effect on alertness and attention, or selective effect on certain brain structure and function. In addition, there are reports about variations found in different individuals. In a lapse hypothesis, decrease of cognitive function is mediated by low attention and decreased alertness which then causes slow response and unstable awake state. Attention fault, a short period of inattentiveness, has been thought to be the main reason behind decrease cognitive function in sleep deprivation.

Partial sleep deprivation can cause a failure in melatonin level during the biological sleeping hours, as an effect of failure in inhibition system and the activated ARAS which result in awaken state. During physiologic sleep, increased melatonin level will be followed by reduced cortisol, IL-6, and orexinlevel, which play part in repairing cognitive function. In partial sleep deprivation, there will be increase of sympathetic activity that results in increased cortisol and IL-6 level, and failure in orexin release. The prefrontal cortex area plays important part in cognitive function in

which disturbance in this area will cause release of cortisol and IL-6. The failure of orexin release causes excessive sleepiness and lower the concentration and sums up to decreased cognitive function during sleep deprivation.[13,14]

In table 3, the resident doctors with less than 7 hour sleep had median (min-max) of cognitive score of 4 (1-11), while those with sleep more than 7 hours had median (min-max) of cognitive score -1 (-2-1). In bivariate analysis using mann-whitney U test, we found that duration of sleep was statistically significant in relation with decreased cognitive function (p<0.001). The duration of sleep varies between individuals, with average of 7-8 hours each day. The amount of sleep <7 hours affects mood and cognitive function.[8] It also disrupts the memory consolidation and restorative process.[13,14] The same result was found in study by Pikovsky et al., where the decreased cognitive function was noted after average of 2.3 ± 0,75 hours of sleep.[7]

The bivariate analysis between age, sex, parental status, education, study program, and coffee consumption were not significant to affect cognitive function. In this study, statistically insignificant results may come from the minimal sample size for the partial sleep deprivation gderoup. This may affect the difference in proportion and significance of the study.

In table 4, it was shown that partial sleep deprivation as independent risk factor in decreased cognitive function after night shift duty, as shown by strong negative correlation (r= -0,866; p<0,001). In addition, the duration of sleep was not found to be independent risk factor, but contributed to the decreased cognitive function along with other variables.

6. Conclusion

Based on the results, we conclude that partial sleep deprivation was statistically significant in taking effect on decrease of cognitive function, with median (min-max) score of 5 (2-11) p<0.001, in resident doctors of Medical Faculty of Udayana University/ Sanglah General Hospital Denpasar.

7. Suggestions

We suggest further study to find correlation between partial sleep deprivation with more specific cognitive domain, such as attention, concentration, orientation, language, memory, visuospatial, and executive with wider and more heterogenous samples, so that statistically significant result can be reached. The effect of sleep deprivation in certain amount of time with the cognitive function needs to be considered also. To increase the quality of education, health service, and working safety, a reformation of the working hours of resident doctors needs to be considered.

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