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## The Relationship among Body Mass Index, Physical Activity, Dynamic Balance and Sleep Patterns

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### Article Info

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### Abstract

According to the World Health Organization in 2010, overweight and obesity are the fifth risk factors of death in the world. Obesity is influenced by the level of physical activity and it could cause a disturbance in dynamic balance and induce sleep disorder known as sleep apnea. Meanwhile, the lack of physical activity also affects the dynamic balance that can increase the risk of fall injury during the dynamic physical activity. The aim of this study was to investigate the relationship among body mass index, physical activity, dynamic balance, and sleep patterns. The subjects of this study were 72 young adults aged 20 years on average, consisted of 47 males and 25 females. The body mass index was undertaken by dividing the body weight (kg) and height in meter square (m<sup>2</sup>). The level of physical activity was performed using the International Physical Activity Questionnaire. Meanwhile, the dynamic balance was measured using the modified Bass test; while sleep patterns were measured using the Pittsburgh Sleep Quality Index. This study found that there was a significant association between BMI and dynamic balance with p value = 0.006 (p < 0.05); whereas physical activity was not significantly associated with the dynamic balance (p > 0.05). Meanwhile, body mass index and physical activity were not significantly associated with sleep patterns (p > 0.05). This study concludes that body mass index has a significant association with dynamic balance. Meanwhile, dynamic balance is highly needed in carrying out dynamic physical activity to avoid fall injury.

## INTRODUCTION

According to the Indonesian Ministry of Health, 26.9% women of population experience overweight, higher than men of 16.3%. The changes in body mass index (BMI) can occur in various ages and genders, which are influenced not only by dietary habits but also by physical activity level (Pudjiadi, 2011). Physical activity is the body movements generated by skeletal muscle and requires energy expenditure. Physical inactivity is the fourth leading risk factor for global death, which causes almost 3.2 million deaths (WHO, 2014). Lack of physical activity will decrease the balance ability because it will decrease muscle mass level and muscle ability, which results in postural control disorders, body balance decrease, and increasing the risk of fall injury (Habut et al., 2016). Balance is the ability to maintain the body in the center of mass against the base of support to resist the center of gravity and is influenced by sensory processes or nervous system, motoric or musculoskeletal, and external effects (Baccolinni, 2013). One of the causes of balance disorders, which are quite common in modern society, is lack of sleep. Several factors, such as workload, health problems, lifestyle, and jet lag, can cause a person to lack sleep. More adults are not getting enough sleep; about 30% of adults worldwide sleep less than 5 hours each night (Sharma and Kavuru, 2010).

The amount of body height and weight will change the center of body gravity and influence body balance. The overweight state will affect body balance and increase the risk of fall injury (Habut et al., 2015). Moreover, less physical activity will weaken and decrease the muscle tone that is important in maintaining body balance (Riskesdas, 2013). On the other hand, overweight and obesity will increase the risk of sleep apnea; and be seen worse in obesity. Meanwhile, some regular physical activity allows individuals to have a longer sleep span and quickly put to sleep. Fatigue due to high activity requires more rest to maintain the balance of energy that has been expended (Apriana, 2015). This study aimed to investigate the association between body mass index and physical activity on body balance and sleep patterns.

## METHODS

### Participants

This study was an analytical observational study with a cross-sectional design. This study was conducted in the Faculty of Medicine, Universitas Sumatera Utara, involving 72 students as subjects. The subjects who had normal vital signs and did not have any histories of balance disorders, fracture of the lower extremities, and not being hospitalized during data collection, were included in this study. This study's procedures were approved by the Health Research Ethical Committee Medical Faculty of Universitas Sumatera Utara/H Adam Malik General Hospital. All subjects had signed the informed consent to join this study after having an explanation about the procedures.

### Procedures of Sampling

The body mass index (BMI) of all research subjects was measured by dividing body weight (kg) and height in meter square (m<sup>2</sup>). The values of the BMI were categorized based on the BMI classification of the Indonesian Ministry of Health, in which the BMI 17.0-18.4 kg/m is categorized underweight, 18.5-25.0 kg/m<sup>2</sup> is normal weight, 25.1-27.0 kg/m<sup>2</sup> is overweight and >27.1 kg/m<sup>2</sup> is categorized obese (Kemenkes, 2012).

### Materials and Tools

The physical activity level was measured through the International Physical Activity Questionnaire (IPAQ) fulfilled by the subjects. The questions in the questionnaire were about the daily activities including types, frequency, and duration with the value of Metabolic equivalents (METs)/minute/week; that was by multiplying the METS value to the type of activity per minute for the duration of the day in a week (walking=3.3, moderate activity=4, and strong activity=8). The results were: light with score <600 METs/min/week, moderate with score 600-1499 METs/min/week, and vigorous with a score >1500 METs/min/week (Hamrik, et al. 2014).

The Modified Bass Test was performed to test the dynamic balance using the technique of jumping over ten boxes with alternating legs over placed boxes and keeping the movement for 5 minutes with the feet covered all over the box. The maximal value was 100, were minus if there were mistakes when landing and balanc-

ing. During the test, the subject must look straight forward. The results of the dynamic balance test were divided into poor with score 14-31, moderate with score 32-49 and good with score 50-68 (Ambegaonkar et al., 2013).

The sleep pattern was identified by filling the Pittsburgh Sleep Quality Index (PSQI) questionnaires that included sleep quality, sleep latency, sleep duration, the efficiency of daily sleep, sleep disturbance, sleep drug use, and daily activities dysfunction. The results of sleep disorder were categorized as good (1-5), mild (6-7), moderate (8-14), and poor (15-21) (Busyee et al., 1989).

### Data Analysis

The data were presented in median  $\pm$  range or in amount (percentage) because the data was not normally distributed according to the Kolmogorov-Smirnov test result. The association of the body mass index and physical activity to dynamic balance and sleep pattern was analyzed using the Chi-Square test. The  $p$  value  $<0.05$  was significant. The statistical analysis was held by using 24th SPSS version.

## RESULT

The subject characteristics included age, sex, BMI, physical activity, dynamic balance and sleep patterns can be seen in the table 1. From Table 1, the majority of subjects were male (58.3%), with BMI categorized normal (58.3%), moderate physical activity (45.8%), dynamic balance reached (79.2%) and sleep patterns were distributed similarly in mild and moderate level (each 43.05%).

Statistically analyzed, the data was performed using Chi Square test, and the data were categorized into 2 categories; the BMI was categorized into obese and non-obese, the physical activity level into good and poor, the dynamic balances into balanced and not balanced, and the sleep patterns into good and poor.

From the Table 2, the non-obese subjects were more balanced compared to the obese ones, and after being analyzed statistically, the association between BMI and dynamic balance was significantly associated

**Table 1.** The Subject Characteristics

Variables	n = 72
Age (years old)	20 (18-20)
Sex	
Male	47 (65.28%)
Female	25 (34.72%)
Body Mass Index (kg/m <sup>2</sup> )	23.50 $\pm$ (18.4 - 40.5)
Underweight (17.0-18.4 kg/m <sup>2</sup> )	1(1.4%)
Normal weight (18.5-25.0 kg/m <sup>2</sup> )	42(58.3%)
Overweight (25.1-27.0 kg/m <sup>2</sup> )	9(12.5%)
Obese (>27.1 kg/m <sup>2</sup> )	20(27.8%)
Physical Activity (METs/minutes/weeks)	853.0 $\pm$ (132.0-2772.0)
Light (<599)	26(36.1%)
Moderate (600-1499)	33(45.8%)
Vigorous (>1500)	13(18.1%)
Dynamic Balance	
Balanced	57(79.2%)
Not Balanced	15(20.8%)
Sleep Patterns	
Mild (1-5)	31(43.05%)
Moderate (6-7)	31(43.05%)
Severe (8-14)	10(13.9%)

with  $p$  value = 006 ( $p < 0.05$ ).

Meanwhile, the majority of the physical activity level among subjects was poor, but it still had a dynamic balanced. And after analyzed statistically, there was no significant association between physical activity and dynamic balance with  $p$  value = 0.732 ( $p > 0.05$ ). see Table 2.

From Table 3, the majority of sleep patterns in the non-obese subjects is good. However, after being analyzed statistically, the association between body mass index with sleep patterns was not significantly associated with  $p$  value = 1,000 ( $p > 0.05$ ).

Also, in the physical activity, even the majority of subjects' physical activity was poor, but they had good sleep patterns, and after being analyzed statistically, there was not a significant association between physical activity and sleep patterns with  $p$  value = 0.074 ( $p > 0.05$ ).

**Table 2.** The Associations of BMI And Physical Activity to The Dynamic Balance

Variables	Total (n=72)	Dynamic Balance		p value	OR (95% CI)
		Not balanced	Balanced		
Body mass index				0.006*	0.168 (0.047± 0.600)
Non obese	43 (59.72%)	4 (26.7%)	39 (68.4%)		
Obese	29 (40.28%)	11 (73.3%)	18 (31.6%)		
PhysicalActivity (METs/minutes/weeks)				0.732	1.554 (0.305 ± 7.914)
Good (<1499)	13 (18.06%)	2 (13.3%)	11 (19.3%)		
Poor (>1500)	59 (81.94%)	13 (86.7%)	46 (80.7%)		

\**p* value<0.05, chi-square test

**Table 3.** The Associations of BMI and Physical Activity on Sleep Patterns.

Variables	Total (n=72)	Sleep Patterns		p value	OR (95% CI)
		Good	Poor		
Body mass index				1.000	0.987 (0.252 ± 3.856)
Non obese	43 (59.72%)	37 (59.7%)	6 (60.0%)		
Obese	29 (40.28%)	25 (40.3%)	4 (40.0%)		
PhysicalActivity (METs/minutes/weeks)				0.074	3.926 (0.922 ± 16.722)
Good (<1499)	13 (18.06%)	9 (14.5%)	4 (40.0%)		
Poor (>1500)	59 (81.94%)	53 (85.5%)	6 (60.0%)		

\**p* value<0.05, chi-square test

## DISCUSSION

In this study, we found that there was significant association between BMI and dynamic balance (*p*-value= 0.006, see Table 2). This study is similar to the study that conducted by Tussakdiah at Esa Unggul University on children aged 10 to 12 years, that study found there was significant association between BMI and balance that were measured with on leg standing method (*p* value = 0.01), that study concluded that higher BMI will lower body balance (Tussakdiah, 2014). The body posture, tall or short, heavy or thin, will change the position of center of gravity and affect body balance. The overweight condition will affect the level of body balance that can increase the risk of being fallen. Beside BMI, the dynamic balance is also influenced by gender that affects the fat distribution on the body (Habut et al., 2016).

The results revealed a significant association between BMI and dynamic balance (*p* value= 0.006, see Table 2). This was similar to the study conducted by Tussakdiah at Esa Unggul University on children aged 10 to 12 years; that study found there was a significant association between BMI and balance that were measured with on leg standing method (*p* value = 0.01). The study concluded that higher BMI would lower body balance (Tussakdiah, 2014). The body posture, such as

tall or short, heavy or thin, would change the center of gravity's position and affect body balance. The overweight condition affected the level of body balance that could increase the risk of falling. Besides BMI, the dynamic balance was also influenced by gender, affecting the fat distribution on the body (Habut et al., 2016).

This study showed no significant relationship between sleep quality and obesity with *p* value = 1,000 (see Table 3). The results of this study are consistent with the study by Bebasari et al. (2015) that also found there was no significant relationship between sleep quality and BMI (*p* = 0.855) in medical students of Riau University in 2014 (Bebasari et al., 2015).

A study conducted by Cauter et al. indicated that sleep influences obesity in adolescents. This happened because of an imbalance between hormones leptin and ghrelin in teenagers who lack sleep, which acted as an appetite suppressor and appetite stimulant and caused balance disorders in the body. Moreover, people lacking sleep experienced fatigue and unwillingness to do physical activity in the morning. To overcome this, they tended to consume more food because they thought fatigue and aversion to physical activity were caused by a lack of food intake (Cauter et al., 2008).

This study showed there was no significant relationship between physical activity with sleep patterns

with  $p$  value  $p = 0.074$  (see Table 3). This research results are not in line with Iqbal's study stating there was a significant relationship between physical activity and sleep patterns ( $p = 0.006$ ) for migrants in Yogyakarta. According to Agustin, one of the factors that contributed greatly to the sleep quality of respondents was the biological clock pattern. Every individual has a biological clock pattern where normal humans would do more activities during the day and rest at night. Changes in the body's physiological rhythms occurred every 24 hours following a regular day and night cycle; this rhythm was known as the circadian rhythm. If a person's lifestyle is irregular, then automatically the circadian rhythm previously owned will change and disrupt the biological clock between sleep and wakefulness, which will affect the pattern and quality of sleep (Iqbal, 2017).

## CONCLUSION

The body mass index was significantly associated with dynamic balance, but not with sleep patterns. Meanwhile, physical activity was not significantly associated with dynamic balance or sleep patterns. This study concluded that the value of body mass index is essential in carrying out dynamic physical activity because, during that physical activity, the dynamic balance is needed.

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