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Association Between Physical Activity, Sleep Quality and Handgrip Strength in Medical Student

Salma Rizqi Amanah[1]✉, Mila Citrawati[2]✉

Faculty of Medicine, Universitas Pembangunan Nasional "Veteran" Jakarta, Indonesia[1]
Departement of Physiology, Faculty of Medicine, Universitas Pembangunan Nasional "Veteran" Jakarta, Indonesia[2]

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Abstract

This study was conducted to determine the association between physical activity and sleep quality with handgrip muscles strength of medical students at Universitas Pembangunan Nasional "Veteran" Jakarta. This study was an analytical observational with cross sectional design. The participants were 75 male students aged 18-22 years old. Random sampling was used for this study. Measurement of physical activity was carried out using the Global Physical Activity Questionnaire (GPAQ) and sleep quality using the Pitsburgh Sleep Quality Index (PSQI) questionnaire. The strength of handgrip muscle was measured using Camry Handgrip Dynamometer. Result showed there was a significant association between physical activity with handgrip strength with significance value of p =0,000 (p <0,05) and sleep quality with p = 0,003 (p <0,05) using 95% CI. Multivariate test showed physical activity had more dominant association with handgrip strength with an OR score of 4,608 . Based on the result, it can be concluded student with good sleep quality and higher level of physical activity tend to have stronger handgrip muscle with physical activity as dominant factor.

How to Cite

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✉ **Correspondence address :**
E-mail: salmarizqi@gmail.com / milacitra@gmail.com

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INTRODUCTION

Muscle is an organ that function to generate movement through contraction (Dorland, 2011). Having strong muscle is useful to support physical activity, because muscle strength is one of physical fitness components (Ratno, 2015). Handgrip dynamometer can be used to measure muscle strength (Nakandala, 2019). In a study that was conducted by Tosclair et al. (2011), the result showed handgrip strength is associated with overall muscle strength, therefore handgrip strength measurement can be used to predict overall muscle strength. The strength of the handgrip requires a combination of actions from a number of hand and forearm muscles (Saputra & Riyadi, 2016). In carrying out daily activities, handgrip muscle has essential role because hands have both gross and fine motor function (Manoharan, 2015). As people get older, there will be a decrease in muscle strength caused by decrease in muscle mass, therefore, it is important to maintain muscle strength since youth (Dwiprakoso, 2013)

Medical students tend to have tight schedules and lots of academic assignments. This results in students not having enough time to exercise and sleep efficiently. This condition can disrupt the secretion of anabolic hormones that function to increase muscle mass and strength, as the result there will be a decrease in muscles strength.

Adequate physical activity can increase muscle mass and contractility so, the muscle strength increases (McArdle, 2010). Riset Kesehatan Dasar 2018 reported there are 33.5% of Indonesians classified as having low physical activity (cumulative physical activity less than 150 minutes per week). The proportion of low physical activity found in the group who were still attending school, which was 59.1%. This showed that students tend to have sedentary behaviour (Badan Penelitian Kesehatan dan Pengembangan, 2018). As a prospective health worker, medical students are expected to be the role in their environment, but a study conducted by Riskawati (2018)on medical students at Brawijaya University, found 60% of students have low level of physical activity. There are several instruments to measure physical activity, Global Physical Activity Questionnaire (GPAQ) is used most often, it was developed by World Health Organization with validity value (r = 0.48) and reliability (Kappa = 0.67-0.73) (Iqbal, 2017).

Besides physical activity, muscle strength is also affected by sleep. The mass and some muscle protein are mostly formed through protein synthesis during the phase of slow wave sleep or Non Rapid Eye Movement (NREM) sleep stage 3, during that phase, the secretion of hormones that controls metabolism and muscle growth occurs. (Berry, 2012; Thukral, 2018). During sleep, the process of muscle tissue repairment will also occur (National Sleep Foundation, 2019). Poor sleep quality is often found in students and workers who have busy schedules.

Poor sleep quality results in decreased concentration during learning process and excessive sleepiness during the day. The tight schedule of activities and the numerous academic assignments cause students to have a tendency to stay up late, inconsistent sleep patterns and lack of efficient sleep.

In a study conducted by Chen et al. (2017) on 10,125 students aged 16-30 years in China, it was reported that students who had sleep duration of less than six hours a day and poor sleep quality, had weaker handgrip muscle strength compared to students who had 7-8 hours sleep duration a day and good sleep quality. This was in accordance with sleep duration recommendation by the National Sleep Foundation for this age group, which is about 7-9 hours per day. However, this study was not in line with the study conducted by Thukral (2018), in this study there was no significant differences between the strength of an individual's handgrip with good or poor sleep quality. The instrument used to assess sleep quality was the Pitsburgh Sleep Quality Index (PSQI) questionnaire, which has a Cronbach's alpha reliability value of 0.83 (Marizki, 2014).

There had not been many studies to investigate the association between physical activity and sleep quality with handgrip strength in medical students, and there were many differences on the results from the study that had been done, therefore it attracted the researcher to investigate the association between physical activity, sleep quality and handgrip strength in Medical students at the Universitas Pembangunan Nasional "Veteran" Jakarta.

METHODS

This was a quantitative study with observational analytic method using a cross sectional approach. This research was conducted in October-November 2019 at Faculty of Medicine Universitas Pembangunan Nasional "Veteran" Jakarta.This research has received ethical approval from the research committee of Universitas Pembangunan Nasional "Veteran" Jakarta number B/2185/X/2019/KEPK.

The type of probability sampling chosen was simple random sampling. Calculation of the sample using two different proportion test formula, obtained 73 minimum research samples. The population of this research were male students from Faculty of Medicine UPN "Veteran" Jakarta as many as 127 students. The sample in this research were students who met the inclusion and exclusion criteria. The inclusion criteria of this research were; male, aged 18-24 years old and having normoweight or overweight Body Mass Index (BMI). As for the exclusion criteria were; students who take sleeping pills, habit of consuming alcohol and smoking, drinking coffee every day for the past one month, taking anabolic steroid drugs, having musculosceletal, respiratory, and neurological dissorder, having upper extremity bone deformity, having history of trauma and upper extremity fractures in the last 3 months.

For the procedure, participants filled in the respondent criteria questionnaire, if they meet the inclusion criteria, participants took Global Physical Activity Questionnaire which contains 17 questions about physical activity at work, transportation and recreational or during leisure time, the results are categorized <600 METs-min/week as low ,600-3000 METs-min/week as moderate and >3000 METs-min/week is classified as high. Pitsburgh Sleep Quality Index questionnaire is used to examine 7 components such as sleep duration, sleep latency, subjective sleep quality, the usage of sleeping pills, sleep effectiveness and dysfuction during the day. The score >5 is classified as poor and ≤5 is classified as good.

The Measuremet of handgrip strength was using digital Camry Handgrip Dynamometer.Meas urement was taken with dominant hand based on American Society of Hand Therapist procedure; (1) The position of the shoulder is adduction (2) Elbow flexion 900 (3) Forearm is in neutral position and wrist dorsoflexion between 0 and 300 (4) Participants grasped the held as strong as they can for 3-5 seconds (5) Measurements were taken three times, with 1 minute break on each contraction. The highest result will be used for statistic test. The score <35.7 is categorized as weak and >35.7 is categorized as strong for 18-19 years old, and for 20-24 years old, >36.8 is categorized as strong while <36.8 is categorized as weak.

Data was analyzed using statistical software. Analysis included univariate, bivariate and multivariate test. In bivariate analysis, data were analyzed using Chi Square test. Multivariate analysis was analyzed using logistic regression. Variables to be analyzed into multivariate analysis were variables with p <0.25 from the bivariate test.

RESULTS AND DISCUSSION

Characteristics of the research sample including age, physical activity level and sleep quality. There are 75 participants. The age range of participants were 18-22 years with the majority aged 19 years old.

Table 1. Physical Activity Level Characteristic

Physical Activity	N	%
Low	31	41,3
Moderate	24	32,0
High	20	26,7
Total	75	100

Based on **Table 1** the majority of physical activity level found in medical student was catagorized low with 31 participants (41.3%), this is in line with the report by Riset Kesehadatan Dasar (2018), the proportion of low physical activity was the most frequent in the group who still attend school, which was 59.1% (Badan Penelitian Kesehatan dan Pengembangan, 2018). The result showed, student tends to have sedentary behavior. This condition is due to the tight academic schedule, so medical students tend to not have time to do vigorous physical activity. The tight lecture schedule resulted in students spending more time sitting in class and listening to lecture materials.

Table 2. Sleep Quality Characteristic

Sleep Quality	N	%
Low	44	58,7
Moderate	31	41,3
Total	75	100

Based on **Table 2** the majority of student had poor sleep quality, which was 44 participants (58.7%). This result was in in line with a study conducted by Thukral on 73 medical students at Santosh University in India, there found 29 students with good sleep quality and 44 students with poor sleep quality. Study conducted by Fenny and Supriatmo on medical students at Brawijaya University, reported the highest levels of psychological stress, anxiety and depression were found in medical students. This condition makes medical students more vulnerable to have poor sleep quality.

Table 3.Handgrip Strength Characteristic

Handgrip Strength	N	%
Weak	42	56
Strong	33	44
Total	75	100

Based on **Table 3** the majority of medical students had weak hangdrip strength, which was 42 participants (56.0%). This is supported with study that was conducted by Dwiprakoso on 84 medical students at the University of Indonesia, their handgrip muscle strength is still classified into weak category, because there are no students with good and excellent handgrip strength (Dwiprakoso, 2013) .

Table 4. Crosstabulation of Physical Activity and Handgrip Strength

Physical Activity	Handgrip Strength						P Value
	Weak		Strong		Total		
	N	%	N	%	N	%	
Low	28	90,3	3	9,7	31	100	0,000
Moderate	9	37,5	15	62,5	24	100	
High	5	25	15	75	20	100	
Total	42	56	33	44	75	100	

Based on **Table 4** the crosstabulation of physical activity with handgrip strength, it was found the majority of students with low physical activity had weak hangdrip strength, which were 28 participants (90.3%). For students with moderate physical activity, the majority had strong handgrip muscle strength which were 15 participants (62.5%) and those with high physical activity had the strongest handgrip muscle, which were 15 participants (75%).

Based on the Chi Square test, the result showed p value of 0.000 ($p < 0.05$) which means there was a significant association between the two variables. The result of this study is in line with study conducted by Ng et al. (2019), in this study on a group of teenage students in Malaysia, showed there was a positive association between handgrip strength and physical activity with p value of 0.001 ($p < 0.05$) in male participants, meanwhile in female participants no significant results were obtained. The result showed that the higher level physical activity level, the higher score of hangdrip strength will be obtained (Ng et al., 2019).

The result is supported by the theory that adequate physical exercise can stimulate muscle hypertrophy and increase muscle strength by stimulating myofibril protein synthesis and inhibiting muscle protein breakdown (McArdle, 2010). One of the most important for controlling muscle protein synthesis is the Mammalian Target of Rapamycin (mTOR) which is a threonine kinase that can facilitate intracellular changes and the environment, including nutrition, energy, manage cell supply, differentiation, and autofagi (Yoon, 2017).

Anabolic effect on physical activity is mediated by growth hormone and the secretion of IGF-1, when it binds to its receptors, it will activate insulin receptor substrate (IRS). IRS phosphorylation activates Phosphatidylinositol 3-Kinase (P13K) and mTOR will become active. Activation of mTOR will stimulate ribosomal protein and translational factor release. Mechanical stimuli during exercise will also activate mTOR via the activation of Phospholipase D1 (PLD1) and the production of phosphatidic acid, so that mTORC1 is activated and a protein synthesis process occurs (Walker et al., 2011; Yoon 2017).

Table 5. Crosstabulation of Sleep Quality with Handgrip Strength

Sleep Quality	Handgrip Strength						P Value
	Weak		Strong		Total		
	N	%	N	%	N	%	
Poor	31	70,5	13	29,5	44	100	0,003
Good	11	35,5	20	64,5	31	100	
Total	42	56	33	44	75	100	

Based on **Table 5** the crosstabulation of sleep quality with handgrip strength, it was found that the majority of medical students with poor sleep quality had weak handgrip strength, which were 31 participants (70.5%). In students with good sleep quality, mostly had strong handgrip strength, which were 20 participants (64.5%).

Based on the Chi Square test, there was a significant association between sleep quality and handgrip strength with p value of 0.003 ($p < 0.05$). This result was in line with studies conducted by Chen (2017) on 10,125 students in China, there found a significant association between sleep quality with handgrip strength with p value <0.001. The muscle strength of male student who slept 7-9 hours were stronger than student who slept less than 6 hours a day In women there was

no significant association, because GH secretion in men can also be affected by the testosterone.

Sleep disturbance can result in two things; changes in the secretion patterns of anabolic hormones such as growth hormone, IGF-1, testosterone and increases glucocorticoids that stimulates protein breakdown and increases expression of myostatin as a negative regulator of skeletal muscle which will reduce muscle protein synthesis. Significant increase in cortisol level is found in individual who often wakes up during their sleep. Twenty four hours plasma cortisol is higher in individuals with shorter sleep duration compared with individuals who have adequate sleep duration (Chrousos , 2016)

The result is supported by a theory that the mass and amount of muscle protein is most formed through protein synthesis during the slow wave sleep phase or NREM 3 sleep, during that phase the secretion of hormone that controls metabolism and muscle growth occurs (Berry, 2012). This was also supported by a study conducted by Reproult (2015) on healthy men, there found a decrease in testosterone levels after sleep time limitation for one week. Sleep is associated with testosterone fluctuations. Testosterone levels increase during sleep and return low when awake. Sleep disturbance will result in inhibition of nocturnal testosterone increase (Berry, 2012). Decreased levels of testosterone will result in decreased binding of cytoplasmic androgen receptors that migrate to the nucleus, regulate transcription and stimulate protein synthesis. (McArdle, 2010). Testosterone can also indirectly cause protein synthesis through inhibition of Regulated in Development and DNA damage responses 1 (REDD1) activity that can block mTOR activity (Florian, 2014)

Table 6. Logistic Regression

Variable	B	Odds Ratio (Exp B)	P Value
Physical Activity	1,528	4,608	0,000
Sleep Quality	0,942	2,564	0,103
Constanta	-3,63	0,000	0,028

Based on **Table 6** Physical activity has a stronger association with handgrip muscle strength than sleep quality. The lower the level of physical activity, a person is more likely to have weak handgrip muscle 4.608 times weaker than participants who have low physical activity while poor sleep quality only has a tendency to have 2.564 times weaker than those who had poor sleep quality. According to study conducted by Thukral (2018) on 73 medical students that found no significant difference on individual's handgrip strength with their sleep quality, this was due to PSQI questionnaire only examines sleep quality for the past 1 month, meanwhile physical activity questionnaire examines the habits that are carried out every week. Age in the study was also classified as young adult and participants were still in good health condition.

Sleep disorders does not directly affect muscle strength, but through a very complex pathway and many hormones involved. Muscle weakness due to poor sleep quality is not much found in healthy individuals, according to Lee (2018), this condition is more commonly found in patients who are hospitalized due to prolonged immobilization and sleep disturbances. These conditions can cause a decrease in neuromuscular function and directly affect muscle strength.

CONCLUSION

Based on the results of data analysis and discussion that have been carried out on this research, there found a significant association between physical activity and sleep quality with handgrip strength of medical student at Universitas Pembangunan Nasional "Veteran" Jakarta. Higher level of physical activity and better sleep quality associated with stronger handgrip muscle. However, for other researchers, it is suggested to involve other factors in the further research, such as nutrition intake and hand anthropometry. It is necessary for the student to increase their level of physical activity and manage their sleep to maintain their muscle strength which is one of physical fitness components.

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