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The Correlation Between Physical Activity Levels With Salivary Cortisol Levels on Medical Students, at Jenderal Soedirman University

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ABSTRACT

Medical students generally have low levels of physical activity. Medical students also experience more severe stressors than students in other study programs. Salivary cortisol levels can reflect a person's stress level. This study aims to determine the correlation between physical activity levels and salivary cortisol levels in medical students at Jenderal Soedirman University.

This study was conducted on 50 medical students at Jenderal Soedirman University aged 18–25 years. The study subjects were selected using purposive sampling. Physical activity levels were measured using the International Physical Activity Questionnaire-Long Form (IPAQ-LF), and saliva cortisol levels were measured using the Enzyme-Linked Immunosorbent Assay (ELISA) method. The correlation test used was Pearson's correlation test with a significance level of p<0.05.

The results showed that the average physical activity level and saliva cortisol levels of the respondents were 1334.31±552.10 MET-minutes/week and 9.76±2.97 ng/mL. Bivariate analysis showed a p-value of 0.507, indicating that there was no correlation between physical activity levels and saliva cortisol levels among medical students at Jenderal Soedirman University.

1. INTRODUCTION

Physical activity is any body movement that is performed by skeletal muscles and requires energy (Piggin, 2020). This activity has been proven to provide various benefits, including in reducing stress through the mechanism of increasing endorphins, serotonin, dopamine, as well as Brain-Derived Neurotrophic Factor (BDNF) which plays a role in emotional stability and mental health (Cao, 2021; Tolahunase et al., 2021; Mahindru et al., 2023). However, the low prevalence of physical activity is still a global problem. Based on a WHO report (2022), as many as 86% of adolescents and 23% of adults in Indonesia do not meet the recommendations of daily physical activity. Chronic stress and elevated cortisol levels in medical students can severely impact their well-being, leading to mental health issues like depression and anxiety, academic difficulties, and physical health problems such as cardiovascular disease. The continuous activation of the HPA axis due to chronic stress can impair cognitive functions crucial for learning and performance and increase the risk of developing chronic diseases (Knezevic et al., 2023)..

Medical students are a group that is very susceptible to stress due to a dense academic load and high competency pressure. Research shows that 56.63% of medical students at the Tarumanagara University experience moderate stress (Setiawan & Lontoh, 2023) and 45.6% of FK students at the University of Lampung experience severe stress (Razaan, 2024). This condition is at risk of increasing cortisol hormone levels through activation of the hypothalamic-pituitary-adrenal (HPA) axis (Mbiydzenyuy & Qulu, 2024). Excessive cortisol in the body can reduce cognitive function, immunity, and even have an impact on mood stability (Sic et al., 2024).

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Investigating how physical activity influences cortisol levels in this population can help clarify whether regular exercise serves as an effective, accessible intervention to regulate stress hormone production and restore healthy HPA function (De Nys et al. 2022) .

Physiological measurements of cortisol can be done through blood or saliva. Saliva cortisol is superior in terms of convenience, non-invasive, stress-free, and reflects free cortisol levels in the body (Nijakowski et al., 2022; Choi, 2022). Salivary cortisol is a suitable biomarker for assessing stress levels, including those experienced by medical students, due to its sensitivity to both acute and chronic stress (AlSahman et al.,2024).. However, the results of studies on the relationship between physical activity and cortisol levels have not been consistent. Research by Gerber et al. (2020) showed an increase in cortisol after moderate physical activity, while Bermejo et al. (2022) found a positive correlation between physical fitness and cortisol levels. The Moyers et al. study (2023) also showed a link between physical activity and cortisol circadian rhythm tilt, although it had no impact on morning levels.

Based on the inconsistencies of previous research results and the importance of understanding the effect of physical activity on physiological stress in the productive age group, further research is needed. Moreover, there are still few studies that specifically discuss the relationship between physical activity levels and salivary cortisol levels in medical students. Therefore, the author is interested in researching the correlation between physical activity levels and salivary cortisol levels in students of the Faculty of Medicine, Jenderal Soedirman University. Whether the better the physical activity of medical students, the better their stress response, as reflected in their saliva cortisol levels.

2. METHOD

This study is observational research with a cross-sectional design. The research was conducted in August 2024, on third-semester students. This research subject was 50 male respondents who were students of the Faculty of Medicine, Jenderal Soedirman University was selected by purposive sampling. The Subject meet Inclusion Criteria that are aged 18–25 years, good nutrition status, and night time sleep, which averaged 6-9 hours per day in the past month. The exclusion criteria are have a history of active smoking and have heavy sychological stress that Known from DASS-42 score ≥26. Physical activity level measurement using the International Physical Activity Questionnaire-Long Form (IPAQ-LF) questionnaire, salivary cortisol levels using the Enzyme Linked Immunosorbent Assay method (ELISA), sleep time, and stress levels. Saliva samples were collected in the morning between 7 and 8 a.m. using the passive droll method. Respondents did not eat, drink, brush their teeth, smoke, or engage in physical activity for 1 hour prior to saliva collection. IPAQ-LF and DASS-42 questionnaires were completed with the help of enumerators within 2 hour. The Cronbach's alpha value for the Indonesian version of the IPAQ - LF and DASS-42 shows that this instrument has good internal reliability, namely around 0.884 and 0,917 (Dharmansyah & Budiana, 2021; Widyana et al, 2020).

The collected data were analyzed univariate and bivariate. Univariate analysis describes each variable and the results of the research are presented in the form of a distribution table. The distribution of study subject characteristics included stress levels, physical activity levels and salivary cortisol levels. Bivariate analysis was carried out to test the significance of the correlation between physical activity level and salivary cortisol levels in students of the Faculty of Medicine, Jenderal Soedirman University using an analytical test Pearson.

3. RESULT AND DISCUSSION

Table 1. Characteristics of Research Subjects

Variable	Mean ± SD
Age (years)	19.84±1.13
Bedtime (Hours)	7.08±0.65
Stress Level	8,10±6,13
Physical Activity Level (MET- minutes/week)	1334.31±552.10
Saliva Cortisol Level (ng/mL)	9.76±2.97

Based on Table 1, it can be seen that the average age, sleep time, stress level, physical activity level and salivary cortisol levels of the study respondents were 19.84±1.13 years, 7.08±0.65 hours, 8.10±6.13, 1334.31±552.10 MET – minutes/week, 9.76±2.97 ng/mL.

Table 2. Frequency Distribution of Stress Levels, Physical Activity Levels, and Saliva Cortisol Levels

Variable	Frequency	Percentage
Stress Level		
Usual	43	86%
Light	3	6%
Keep	4	8%
Physical Activity Level		
Low	4	8%
Moderate	46	92%
High	0	0%
Saliva Cortisol Levels		
Low	2	4%
Usual	48	96%

Based on Table 2, it was found that 80.0% of respondents had normal stress levels, 92.0% of respondents had physical activity levels *moderate* and 96.0% of respondents had normal cortisol levels.

Table 3. Pearson Correlation Analysis Results

Variable	r	*p*
Physical Activity Level Saliva Cortisol Levels	0,096	0,507

Table 3 is the result of a bivariate analysis to determine the relationship between physical activity level and salivary cortisol levels using an analysis test *Pearson.* The results of the bivariate analysis of physical activity level with salivary cortisol levels in Table III showed a value of p=0.507 (p>0.05) which means that there was no significant correlation between physical activity level and salivary cortisol levels.

Discussion

The respondents in this study were 50 students of the Faculty of Medicine, Jenderal Soedirman University, with an average age of 19.84 ± 1.13 years. All respondents were in the young adult age range (18–25 years), which is a period with relative stability of cortisol levels and peak development of physiological adaptive abilities to stress (Moffat et al., 2020; Nurhasanah et al., 2024). This age is also important to assess the influence of physical activity on optimal hormonal regulation (Candrawati, 2011). Most respondents had adequate sleep duration, with an average of 7.08 ± 0.65 hours per night. This is in line with the National Sleep Foundation's recommendations for 18–25-year-olds. Adequate sleep plays an important role in maintaining the circadian rhythm of cortisol and can lower cortisol levels that increase due to chronic stress (O'Byrne et al. 2021; Afriani et al., 2019).

The majority of respondents (86%) showed normal levels of stress based on the results of the DASS-42 questionnaire. Respondents with severe stress were excluded from the study to avoid bias, as severe stress can lead to a significant increase in cortisol levels through activation of the HPA axis (Sumardiyono, 2020). In contrast, subjects with mild to normal stress were more representative to see the influence of other factors such as physical activity on cortisol levels. The physical activity level of the respondents was moderate (92%) with an average of 1334.31 ± 552.10 MET-minutes/week. This value is higher than the WHO's minimum threshold of 600 MET-minutes/week, indicating that most subjects have met the requirements of healthy physical activity. However, measurements were carried out using the IPAQ-LF questionnaire which was

subjective, and tended to cause overestimation due to recalled bias and minimum assessment of activity duration (Wanner et al., 2016).

he results of salivary cortisol measurements showed an average of 9.76 ± 2.97 ng/mL, which is in the normal range (5–21.6 ng/mL). The use of saliva samples has the advantage of being non-invasive and reflecting free cortisol levels more accurately than total blood (Nijakowski et al., 2022; Ciancia et al., 2023). All samples were taken using the passive drool method in the morning (07.00–08.00) to control the influence of circadian rhythms.

Based on Table 3, the results showed that there was no significant relationship between physical activity level and salivary cortisol levels (r = 0.096; p = 0.507). These results are in line with De Nys's research et al. (2022) stated that there was no significant effect between physical activity and serum cortisol levels. The research conducted by De Nys has similarities with this research, which is conducted on young adult subjects. The results of this study are also in line with the experimental research conducted by Magalhães et al. (2020) that there was no significant change in the hormone cortisol after being given high-intensity interval training or moderate continuous interval training with resistance training. The insignificant results may be due to the fact that the study was conducted in August 2024 on third-semester students. The students had just returned from their semester break, so most of them had low stress levels. In addition, the types and intensity of physical activities performed during the break also varied.

The results of this study have different results from previous research. Valera-Calero & Varol (2022) mentioned the results that there was a correlation between cortisol taken from saliva and the level of routine activity in office workers. In addition, Caplin et al. (2021) compared three groups of active physical activity with the result that cortisol concentrations were higer in the vigorous group. These different results are due to differences in the characteristics and stressors experienced by respondents and differences in the characteristics of respondents' physical activities. Valera-Calero & Varol 's study was conducted on office workers who had different stressors, while this study was conducted on students. Caplin et al, (2021) study was conducted on three groups with equal levels of physical activity, while this study mostly involved respondents in the moderate level category.

There is a difference in the results of the research conducted showing that there is no correlation between physical activity level and salivary cortisol levels can be caused by several limitations such as uncontrolled confounding factors such as body mass index (BMI), as well as the use of subjective instruments such as IPAQ. Respondents often misremember or miscalculate their physical activity—especially light and moderate intensity movements like walking or sitting—which are fragmented and not consciously tracked. Classifying these into ‘vigorous’, ‘moderate’, or ‘light’ adds cognitive difficulty. Many studies find that respondents struggle with recall, frequency/duration estimation, and intensity categorization (Kercher et al, 2024). If possible, it can be combined with objective methods using an accelerometer or pedometer. BMI is known to be associated with HPA dysregulation and increased cortisol levels in obese individuals (Badr et al., 2025).

4. CONCLUSION

Based on the results of the study, it was found that there was no correlation between physical activity levels and salivary cortisol levels in students of the Faculty of Medicine, Jenderal Soedirman University. Students of the Faculty of Medicine, Jenderal Soedirman University have an average physical activity level of 1334.31±552.10 MET-minutes/week with an interpretation of physical activity level moderate. Meanwhile, students of the Faculty of Medicine, Jenderal Soedirman University had an average salivary cortisol level of 9.76±2.97 ng/mL with an interpretation of cortisol levels within normal limits.

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