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Relationship between physical activity, stress levels, and sleep quality in adolescents

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ABSTRACT

Background: Quality sleep is important for recovery, but adolescents often experience sleep disturbances during puberty. Low physical activity, such as playing online games, and stress from many tasks can reduce their sleep quality. This study aimed to determine whether there is a relationship between physical activity level and stress on sleep quality in adolescents.
Methods: This research used observational analytics method with a cross-sectional design. The study used apurposive sampling of 232 people in junior high schools in Denpasar. The inclusion criteria were teenagers aged 16-17, while the exclusion criteria were respondents who smoked, drank alcoholic beverages, and took sleeping pills. Data were collected by measuring physical activity levels using the international physical activity questionnaire (IPAQ), stress using the depression anxiety and stress scale (DASS-21), and sleep quality using the Pittsburgh sleep quality index (PSQI).
Results: Based on the results of the non-parametric analysis of *Spearman Rho*, it showed that there was a relationship between physical activity and sleep quality with a significance value of p = 0.001 (p <0.05) correlation coefficient (r = 0.464). There was a relationship between stress and sleep quality with a value of p = 0.001 (p <*O*.05) correlation coefficient (r = 0.671).
Conclusion: Based on the results, it could be concluded that there was a relationship between physical activity level and sleep quality in adolescents. There was also a relationship between stress and sleep quality in adolescents.

Keywords: adolescents, physical activity, psychological stress, sleep quality.
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INTRODUCTION

Adolescence is the transition from childhood to adulthood, characterised by growth, physical development, and psychological maturation, defined psychologically by changing behaviour, emotions, moods, and desires, and biologically by the growth and development experienced by adolescents.[1] During this period, emotional moods are often unstable because hormonal changes influence them in the body.[2] Adolescents during puberty often face changes that can shorten or reduce the time spent resting or sleeping.[3] Moreover, adolescents now sleep too late at night, resulting in adolescents often feeling sleepy at school during the day.[4]

Based on data from the Ministry of Health of the Republic of Indonesia in 2018, adolescents are recommended to sleep 8 to 9 hours daily.[5] Research by the National Sleep Foundation (NSF) states that 15% of teenagers feel sleepy at school, and 60% feel tired during the day.[6] Adolescents have sleep habits that vary from people of different ages since they undergo several changes during adolescence. In addition, lifestyle influences such as smoking, alcohol, and burden on the mind affect learning efficiency.[7] Some situations caused by poor sleep include lack of concentration in learning, forgetfulness, and nervousness.[7] Teenagers' sleep quality can also be affected by using computers all day, reading books, or completing assignments without doing physical exercises such as stretching.[8]

Adolescent sleep patterns are unconsciously influenced by physical activity. This is due to activities that involve physical activity in adolescents both in and out of school.[8] Although lack of physical activity can decrease sleep quality, high physical activity can help avoid it. The causes of physical inactivity include individual behaviour and laziness, adolescents who dislike exercise and would rather lie down and play online games than engage in physical activity, and even other factors such as sitting are just some of the reasons for physical inactivity.[9] Increased energy needs during activity require adjustments from balanced blood circulation to keep the body metabolising properly. Physical activity helps regulate the body's circadian rhythm, which affects the sleep-to-wake cycle, timing, and duration of falling asleep.[10]

In addition to a lack of physical activity, stress can also affect the quality of sleep experienced by adolescents. The level of stress that occurs in adolescents is 10 to 20%, whereas in terms of emotional responses, some adolescent girls tend to be more often stressed.[11] This is because teenage girls tend to show emotions that focus on feelings in early adolescence

and prefer to reflect on emotions.[11] Stress adversely affects all aspects of life, whether physical, psychological, or social. Each individual responds to stress in different ways. Some common symptoms include sleeplessness, weight gain or loss, anger, difficulty concentrating, headaches, social isolation, and fatigue. Various factors influence adolescent sleep quality, including lifestyle habits and psychological stress.[12] This study aimed to determine whether there is a relationship between physical activity level and stress on sleep quality in adolescents.

METHODS

This study used an analytical observational method with a *cross-sectional* design. The variables studied were taken at once during the research process. 13 It involved three independent variables: physical activity and stress, and one dependent variable, sleep quality.

This study was conducted in 3 high schools from August 2023 to November 2023. The subjects of this study were high school adolescents aged 16-17 years in Denpasar. The number of samples who had filled out the initial questionnaire was 258 students, and was collected by the purposive sampling method. The number of samples obtained according to the inclusion and exclusion criteria was determined using a sampling technique. The inclusion criteria included high school students aged 16-17 years, specifically those in grades first and second, who were willing to participate as subjects and signed a consent form. The exclusion criteria included respondents who smoked, consumed alcoholic beverages, or used medication for sleep. 26 samples were excluded, and the total sample size in this study was 232 people. The inclusion criteria in this study were high school adolescents aged 16-17 in classes X and XI who were willing to become research subjects. The exclusion criteria are adolescents who smoke, consume alcoholic beverages, and take sleeping pills.

The study began with an explanation of how to fill out the questionnaire and the purpose and benefits of participating in this study. Then, questionnaires were distributed using Google Forms to measure physical activity, stress, and sleep quality. Physical activity was measured using the IPAQ. IPAQ measures physical activity using the MET classification method of minutes a week. Stress level using DASS-21, based on the score that will be obtained if 0-14 is categorised as usual, 15-18 is classified as mild stress, 19-25 moderate stress, 26-33 as severe stress, and ≥ 34 is categorised as very severe stress. PSQI is the sleep quality measurement tool. Respondents receiving (≤5) points indicated good, while more than (>5) points indicated having sleep problems. All data that has been collected is then statistically processed by computer.

The statistical tests used in this study were univariate and bivariate analyses using SPSS 26.0. Univariate analysis examined each study's characteristics, such as age, class, gender, physical activity, stress, and sleep quality. Bivariate analysis used the Spearman rho correlation with the Spearman rank statistical test to analyse the relationship between physical activity, sleep quality, and stress and sleep quality.

RESULTS

As shown in Table 1 regarding the characteristics of the research subjects, 172 people (74.1%) were 16 years old, and 60 people (25.9%) were 17. Based on class characteristics, most subjects in class XI were 133 people (57.3%), and in class X were 99 people (42.7%). They were followed by female gender characteristics, 128 people (55.2%), and male 104 (44.8%). In addition, the majority of subjects had low physical activity, as many as 85 people (36.6%), moderate as many as 76 people (32.8%), then followed by heavy physical activity, 71 people (30.6%). Furthermore, the characteristics of normal stress were 83 people (35.8%), mild stress 72 people (31.0%), moderate stress 57 people (24.6%), and severe stress 20 people (8.6%). The last characteristic is that most subjects experienced poor sleep quality in as many as 150 people (64.7%), compared to good sleep quality in 82 people (35.3%).

Based on Table 1, the mean value of the whole subject's physical activity was 2.06, with a standard deviation of 0.820. The

Table 1. Results of analysis of respondent characteristics

Characteristics	n (%) or mean ± SD
Age	
16	172 (74.1)
17	60 (25.9)
Grade year	
First	99 (42.7)
Second	133 (57.3)
Gender	
Male	104 (44.8)
Women	128 (55.2)
Physical activity	
Weight	71 (30.6)
Medium	76 (32.8)
Low	85 (36.6)
Stress	
Normal	83 (35.8)
Lightweight	72 (31.0)
Medium	57 (24.6)
Weight	20 (8.6)
Very Heavy	0
Sleep quality	
Good	82 (35.3)
Bad	150 (64.7)
Physical activity	2.06 ± 0.82
Stress	12.06 ± 0.97
Sleep quality	1.65 ± 0.48

n, frequency; %, percentage; SD, standard deviation

Table 2. Cross-tabulation of physical activity on sleep quality

Physical activity	Sleep quality				Total	
	Good		Bad			
	n	%	n	%	n	%
Weight	44	62.0	27	38.0	71	30.6
Medium	31	40.8	45	59.2	76	32.8
Lightweight	7	8.2	78	91.8	85	36.6
Total	82	35.3	150	64.7	232	100.0

n, frequency; %, percentage

Table 3. Cross-tabulation between stress and sleep quality

Stress	Sleep quality				Total	
	Good		Bad			
	n	%	n	%	n	%
Normal	67	80.7	16	19.3	83	35.8
Lightweight	12	16.7	60	83.3	72	31.0
Medium	3	5.3	54	94.7	57	24.6
Weight	0	0.0	20	100.0	20	8.6
Very heavy	0	0.0	0	0.0	0	0
Total	82	35.3	150	64.7	232	100.0

n, frequency; %, percentage

Table 4. Spearman's correlation results Physical activity with sleep quality stress and sleep quality

Variable correlation	r	*p*-value
Physical activity with sleep quality	0.464	0.001
Stress and sleep quality	0.671	0.001

r, correlation coefficient

average overall stress level was 12.06, with a standard deviation of 0.974. Furthermore, the sleep quality of the whole subject obtained an average value of 1.65, with a standard deviation of 0.479.

Table 2 shows that adolescents with heavy physical activity 44 have good sleep quality, and the remaining 27 have poor sleep quality. Among adolescents with moderate physical activity, 31 have good sleep quality, and the remaining 45 have poor sleep quality. Of adolescents with light physical activity, 7 have good sleep quality, and the remaining 78 have poor sleep quality. So, based on the cross-tabulation results, it is found that adolescents with high physical activity have better sleep quality than those with low physical activity.

Table 3 shows that adolescents in the normal stress category are 67 people with good sleep quality, and the remaining 16 have poor sleep quality. In adolescents with mild stress category, as many as 12 people have good sleep quality, and the remaining 60 people have poor sleep quality. Adolescents experience moderate category stress; as many as three people have good sleep quality, and the remaining 54 have poor sleep quality. Furthermore, among adolescents with severe stress categories, as many as 20 people have poor sleep quality. So, based on the results of the cross-tabulation, it is found that adolescents with normal stress categories are more likely to get good sleep quality.

Based on Table 4, the results of the *Spearman Rho* non-parametric analysis test obtained a significance value of $p = 0.001$ ($p < 0.05$), meaning a significant relationship exists between physical activity and sleep quality in adolescents in Denpasar City. In addition, the results of this analysis test also obtained a correlation coefficient of 0.464 and a positive value. This shows that the higher the adolescents' physical activity, the better their sleep quality. In addition, based on the analysis results obtained a significance of $p = 0.001$ ($p < 0.05$), there is a significant relationship between stress levels and sleep quality in adolescents in Denpasar City. The correlation coefficient of 0.671 in the analysis results shows a positive relationship. The positive value means that the two variables have a unidirectional relationship with a strong correlation level.

DISCUSSION

This study found that subjects tended to do more low activity than moderate physical activity, such as cycling at a moderate speed, walking, and running. In addition to doing moderate physical activity, subjects with heavy physical activity also performed less than subjects with low physical activity. In addition, this could be due to the increasing academic load to prepare for exams, such as end-of-semester exams, so the time used in activities is reduced.[14]

This research is supported by Baso et al. (2019), who examined the correlation between physical activity and sleep quality in adolescents. The study showed a significance of 0.001, which means there is a relationship between the two variables with an odds ratio (OR) value of 2.5, stating that active adolescents have a good chance of sleep quality 2.5 times higher than less physically active adolescents.[15]

Research conducted by Mintardjo et al. (2022) examined the relationship between physical activity, sleep quality, and quality of life of school students in Tomohon City.

The results obtained a significant positive correlation (p<0.01); the higher the activity performed, the higher the quality of life in adolescents. In addition, the study also found a significant correlation (p<0.01): the better the quality of sleep, the higher the quality of life of adolescents.[16]

This statement is also supported by Carson et al. (2016). This study concluded that the total time spent on various physical activities throughout the day in children and adolescents was correlated with several health indicators measured. A p-value of <0.01 indicates an association between physical activity composition and all health indicators measured in this study. This confirms that daily physical activity impacts the health of children and adolescents. Time in a day spent sitting and light activity tends to increase risk, while moderate to vigorous activity and adequate sleep can reduce risk. Therefore, it is important to consider a variety of activities in 24 hours, not just one type of activity.[17]

Active teenagers have better sleep quality overall. Under normal conditions, changes in sleeping hours follow the natural pattern of the day and night cycle. This process generally depends on the body's natural biological clock. This activity generates circadian rhythms for the release of melatonin.[18] If the energy in the body is not released regularly, the previously regular circadian rhythm will be disrupted, leading to an imbalance in the biological clock between sleeping and waking up, which can affect the quality of sleep. If adolescents change this habit, it will lead to changes in their cycle.[19]

Based on the results of subjects with normal stress more than subjects with mild, moderate, or severe stress, it must still be considered because stress hurts all aspects of life, both physical, psychological, and social.[20] This may be due to adolescents' adaptation to new challenges in adolescence, such as increased academic guidance, changes in social environment, and getting to know themselves. Hormones often cause 21 adolescents to experience stress. Adolescent girls and boys tend to respond to stress differently, as boys are better able to cope with stress through behavioural changes, such as smoking, drinking alcohol, and drug use. Meanwhile, females tend to respond to stress by changing their mood.[21]

Research conducted by Muhafilah and Suwarningsih (2023) examined the relationship between the duration of using social media, stress levels, and sleep quality in adolescents. Researchers used a *chi-square* test that showed adolescents experiencing stress tended to have poor sleep quality (75%) higher than adolescents with mild stress (43.2%), and this difference was significant, with a p-value = 0.016. The research has found certain factors that influence the relationship between stress levels and adolescent sleep quality, such as difficulty concentrating and pressure in studying. This causes the majority of adolescents to experience decreased sleep quality. Adolescents with poor sleep quality tend to spend longer time on social media.[22]

Research conducted by Tarlemba et al. (2018) showed different results. Researching the relationship between stress levels, smartphone addiction, and also sleep quality disorders in adolescents. The results showed that 74.4% of adolescents experienced moderate stress with impaired sleep quality, and no significant correlation was found between stress levels and sleep quality disorders (p = 0.925). This is because social interaction and physical activity can be a way for adolescents to cope with stress so that it does not interfere with their sleep. Therefore, maintaining mental and physical health through exercise can help reduce the impact of stress on adolescent sleep.[23]

When the body is under stress, the adrenal glands respond by increasing the production of the hormone cortisol. Cortisol plays a role in responding to stress, which helps boost energy in the body. However, an excessive increase in cortisol can disrupt the hormonal balance in the body and impact sleep quality. In addition, stress can also affect the production of melatonin, a hormone that controls the sleep cycle. Stress disrupts the production of melatonin, which disrupts the sleep cycle and can lead to sleep disorders.[24] Both acute and chronic stress can negatively impact an individual's behaviour, increasing the risk of poor sleep quality. Stress interacts with psychosocial resilience to create physiological stress.[25]

There were certain restrictions to this research. Firstly, other factors, such as teenagers' habit of using gadgets at night before bed, significantly affecting sleep quality, were not controlled by the researcher. The study did not account for environmental factors like room temperature, noise levels, and light exposure, which can influence sleep. The reliance on self-reported data introduces potential bias due to inaccurate recollections or intentional misreporting. Furthermore, the sample size and demographic diversity needed to be adequately addressed, limiting the generalizability of the findings. Lastly, the study might use longer follow-up design to capture effects of the physical activity and stress level on sleep quality.

CONCLUSION

The research concluded that there was a significant relationship between physical activity and adolescent sleep quality, with a moderate correlation. In addition, there was a strong correlation between stress and sleep quality in adolescents.

ETHICAL CLEARANCE

The Research Ethics Commission of the Faculty of Medicine at Universitas Udayana approved this study, deeming it ethically feasible under reference number 2491/UN14.2.2.VII.14/LT/2023.

CONFLICT OF INTEREST

There are no conflicts of interest in this research.

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AUTHOR CONTRIBUTIONS

NKABLD developed the research design, collected and analysed the data, and drafted the manuscript. SAPT, IPYPP, and GPK interpreted the results of the data analysis and revised the manuscript.

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