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Effect of Sedentary Lifestyle on Body Mass Index and Cardiovascular Endurance in Adolescents

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ABSTRACT

Background: Sedentary lifestyles are increasingly common among adolescents and can negatively impact health, including increased body mass index (BMI) and decreased cardiovascular endurance.

Research Methods: This study aimed to analyze the influence of sedentary lifestyle on BMI and cardiovascular endurance in 34 adolescents aged 15–18 years with a quantitative approach and cross-sectional design. Data were collected using IPAQ, BMI calculations, and Harvard Step Test, and then analyzed using simple linear regression.

Research Result: The results showed that sedentary lifestyle had a significant effect on BMI (β=0.82, $p<0.001$, R^2=0.48) and cardiovascular endurance (β=-2.15, $p<0.001$, R^2=0.60). The higher the sedentary time, the greater the BMI and the lower the cardiovascular endurance.

Conclusion: This study emphasize the importance of reducing sedentary time to maintain adolescent health, as well as recommend further research with a longitudinal design.

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1. INTRODUCTION

Sedentary lifestyles have become an increasing global phenomenon, especially among adolescents. Technological advancements, such as the presence of smartphones, computers, and televisions, provide convenience but also encourage physically inactive behavior (Silveira et al., 2022). A sedentary lifestyle is defined as activities with very low energy expenditure, such as sitting, watching television, or using digital devices for long periods of time (Wachira, 2021). In recent decades, this shift has had a significant impact on the physical and mental health of individuals, especially in the adolescent age group.

Adolescents are an age group that is very vulnerable to lifestyle changes (Febriyanty & Faizin, 2022). They are in a phase of rapid physical and psychological development, where physical activity plays an important role in supporting overall health. However, with more and more time spent on sedentary activities, such as playing video games or using social media, many teens are lacking in the physical activity necessary to maintain optimal health. The World Health Organization (WHO) notes that lack of physical activity is one of the four main risk factors for death worldwide, and sedentary lifestyles have been identified as a major contributor to this phenomenon (Martins et al., 2021; WHO, 2019). A sedentary lifestyle has a direct impact on the body's metabolic pattern (Nafi'ah & Hadi, 2022). When the body is inactive for a long time, calorie burning becomes minimal, resulting in an energy imbalance (Winn et al., 2019). In addition, low physical activity also leads to reduced insulin sensitivity and an increased risk of visceral fat accumulation (Yaribeygi et al., 2021). As a result, individuals who lead a sedentary lifestyle are more prone to being overweight or obese.

Body Mass Index (BMI) is a simple tool to classify a person's nutritional status based on weight and height (Mohajan & Mohajan, 2023). BMI is calculated by dividing body weight (kg) by the square of height (m). The BMI category is usually divided into underweight, normal, overweight, and obese. In adolescents, BMI is used as an indicator to monitor nutritional status in relation to health and disease risk in the future (Gutin, 2018). Sedentary activities, such as watching television, playing video games, or using electronic devices, are usually associated with low levels of physical activity. In these conditions, energy expenditure becomes very minimal, while calorie intake often remains unchanged or even increased due to the consumption of high-calorie snacks. This energy imbalance is a major factor that leads to weight gain and increased BMI in individuals who lead sedentary lifestyles (Blüher, 2019). Adolescents with high BMI often face the additional challenge of low participation in physical activity. Excess weight can cause discomfort or fatigue faster when exercising (Gar et al., 2020). This creates a vicious cycle, where a high BMI limits physical activity, while a lack of physical activity exacerbates a sedentary lifestyle and increases the risk of further weight gain. Previous research has shown that adolescents who spend more than 6 hours a day in sedentary activities have a higher likelihood of becoming overweight compared to those who are more physically active (Skrede et al., 2019).

Cardiovascular endurance is an important component of physical fitness that is often affected by a sedentary lifestyle (Teresa et al., 2018). Cardiovascular endurance is the body's ability to maintain the function of the heart, lungs, and blood vessels in support of physical activity that lasts for a long time (Rohman, 2019). This ability is essential to ensure the distribution of oxygen and nutrients throughout the body, especially to active muscles, thereby supporting daily activities and preventing cardiovascular disease. Good cardiovascular endurance is usually measured through aerobic capacity or VO_2 max, which is

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the maximum amount of oxygen the body can use when exercising at high intensity. A sedentary lifestyle, characterized by long sitting durations and minimal physical activity, has a significant negative impact on cardiovascular endurance. Sedentary activity reduces the efficiency of the heart and lungs in pumping blood and supplying oxygen to body tissues (Lurati, 2018). This habit causes the heart muscle to become less trained, so cardiovascular endurance is reduced. Decreased cardiovascular endurance due to lack of physical activity can lead to a decrease in overall quality of life and increase the risk of cardiovascular disease in the future. Undersedentary adolescents often show low aerobic capacity, which is an early indicator of potential heart health problems later in life (Mateo-Orcajada et al., 2022).

In the Indonesian context, changes in the increasingly modern lifestyle of society also affect the physical activity habits of adolescents. Data from the Ministry of Health of the Republic of Indonesia shows that the prevalence of obesity in adolescents has increased significantly in recent years (Nugroho, 2020). This indicates that lack of physical activity and high involvement in sedentary activities are public health issues that need to be taken seriously. Unfortunately, awareness of the importance of adequate physical activity and the negative impact of a sedentary lifestyle is still low among adolescents and their parents. Research in different countries shows that targeted interventions to reduce sedentary activity and increase physical activity can provide significant benefits. For example, an increase in the habit of walking or cycling to school has been shown to lower BMI and increase aerobic capacity in adolescents (Haryani, 2024). On the other hand, efforts to reduce screen time can also help create a better balance of energy and improve cardiovascular endurance. However, in Indonesia, there are still few studies that specifically evaluate the relationship between sedentary lifestyle, BMI, and cardiovascular endurance.

Therefore, this study aims to fill this gap by evaluating the relationship between sedentary lifestyle and BMI and cardiovascular endurance in adolescents in Indonesia. A better understanding of these relationships is expected to be the basis for more effective intervention efforts to improve adolescent health in Indonesia. Thus, this research is expected to contribute to efforts to improve the quality of adolescent health in Indonesia through a better understanding of the impact of sedentary lifestyles on their physical health. The research also serves as a basis for more targeted interventions to prevent future health problems due to sedentary lifestyles.

2. METHODS

This study used a cross-sectional design to analyze the influence of sedentary lifestyle on body mass index (BMI) and cardiovascular endurance in adolescents. The study population was adolescents aged 15–18 years, with samples taken by purposive sampling from secondary schools in Makassar city. The research instruments included questionnaires used to measure the duration of sedentary activities such as watching television, playing gadgets, and learning in a sitting position, as well as direct measurements of BMI based on body weight (kg) and height (m) using the kg/m² formula. Cardiovascular endurance is measured using the Harvard Step Test to calculate maximum aerobic capacity (VO2 max). The collected data were statistically analyzed using descriptive and inferential approaches to determine the relationship between sedentary lifestyle and BMI and cardiovascular endurance.

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3. RESULTS AND DISCUSSION

Table 1. Descriptive Statistics

Variabel	N	Min	Max	Mean	Median	Std.Dev
Age (years)	34	15	18	16.6	16	1.1
Sedentary Lifestyle (Hours/Day)	34	3.6	9.5	6.9	7.4	1.8
IMT (kg/m²)	34	18.7	30.1	23.9	23.4	3.2
Cardiovascular Endurance (Score)	34	50	85	66.7	68	9.8

The average age of respondents in this study was 16.6 years, with the majority aged between 15 and 18 years. The age variation is relatively small, as indicated by the standard deviation of 1.1 years. The average time of the respondents' sedentary lifestyle was 6.9 hours per day, with a minimum time of 3.6 hours and a maximum of 9.5 hours. The distribution of data showed that there was a variation in the level of sedentary lifestyle among the respondents, with a standard deviation of 1.8 hours per day. The respondents' Body Mass Index (BMI) averaged 23.9 kg/m², which falls into the normal category, with a minimum value of 18.7 kg/m² and a maximum of 30.1 kg/m². Cardiovascular endurance data showed an average score of 66.7, with a score range from 50 to 85. The distribution of this endurance score shows the diversity of the cardiovascular conditions of the respondents, with a standard deviation of 9.8.

Table 2. Category Frequency Distribution

Variabel	Category	Frequency	Percentage (%)
Categories Sedentary Lifestyle	Low	6	17.6
	Keep	11	32.4
	Tall	17	50.0
Category: IMT	Normal	20	58.8
	Overweight	10	29.4
	Obesity	4	11.8
Categories Cardiovascular Endurance	Bad	14	41.2
	Normal	10	29.4
	Good	10	29.4

Most respondents (50%) had a high sedentary lifestyle, followed by 32.4% in the medium category, and 17.6% in the low category. This data indicates that more than half of respondents tend to have less active daily activity patterns. In terms of nutritional status, the majority of respondents (58.8%) had BMI in the normal category, while 29.4% were in the overweight category, and only 11.8% were obese. This shows that most respondents are weighing in line with their height, although there is a significant proportion in the overweight category. In the cardiovascular endurance variable, 41.2% of respondents had endurance in the poor category, while the normal and good categories each covered 29.4% of respondents. These data show that almost half of the respondents have low levels of cardiovascular endurance, which is potentially related to a high sedentary lifestyle.

Table 3. Linear Regression - Sedentary Lifestyle against BMI

Parameter	coefficient	Std. Error	T-Statistics	p-value	Desc.
Intersep (β_0)	18.25	2.10	8.69	0.001	sig.
Sedentary Lifestyle (β_1)	0.82	0.15	5.47	0.001	sig.
R^2	0.48	-	-	-	Independent variables explain 48% BMI variability

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The results of linear regression analysis show that a sedentary lifestyle has a significant positive influence on body mass index (BMI). A regression coefficient of 0.82 indicates that every 1 hour/day increase in a sedentary lifestyle will increase BMI by 0.82 kg/m². A p-value of less than 0.001 indicates that this effect is significant at a 95% confidence level. In addition, an R^2 value of 0.48 indicates that a sedentary lifestyle explains 48% of the variability in BMI, while the rest is influenced by other factors outside of this model.

Overall, these results suggest that high sedentary time correlates with increased BMI in adolescents, so a more active lifestyle needs to be considered to prevent the risk of overweight or obesity.

Table 4. Linear Regression - Sedentary Lifestyle to Cardiovascular Endurance

Parameter	coefficient	Std. Error	t-Statistics	p-value	Desc.
Intersep (β_o)	78.45	3.95	19.86	< 0.001	Sig.
Sedentary Lifestyle (β_1)	-2.15	0.30	-7.17	< 0.001	Sig.
R^2	0.60	-	-	-	Independent variables explain 60% cardiovascular endurance variability

Based on linear regression analysis, a sedentary lifestyle has a significant negative influence on cardiovascular endurance. A regression coefficient of -2.15 indicates that every 1 hour/day increase in sedentary lifestyle leads to a decrease in cardiovascular endurance score by 2.15 points. With a p-value of less than 0.001, this relationship is significant at a 95% confidence level. An R^2 value of 0.60 indicates that a sedentary lifestyle explains 60% of the variability of cardiovascular endurance scores, which indicates this model is quite robust.

These results suggest that a higher sedentary lifestyle is associated with decreased cardiovascular ability. Therefore, reducing sedentary time can be an important step in improving cardiovascular endurance in adolescents.

3.1. Discussion

The results showed a significant relationship between a sedentary lifestyle and Body Mass Index (BMI) and cardiovascular endurance. A sedentary lifestyle, characterized by low physical activity and high sitting time, has been shown to be one of the main factors for increased BMI and decreased cardiovascular capacity. This finding is important in the context of the increasing prevalence of sedentary lifestyles across different age groups, especially among office workers and students.

This study confirms that a sedentary lifestyle has a positive correlation with BMI. Individuals with longer sitting time tend to have higher BMI compared to those who are more physically active. This is consistent with previous research, such as that conducted by (Westerterp, 2018), which showed that low physical activity can lead to increased body fat mass and the risk of obesity. In addition, (Wheeler et al., 2020) emphasize that long durations of sitting time interfere with lipid and glucose metabolism, which ultimately contributes to weight gain. In the context of this study, most of the participants who had a sedentary lifestyle experienced an increase in BMI above normal. Minimal physical activity reduces daily calorie burn, making surplus energy more likely. This energy imbalance is one of the main causes of weight gain and obesity (Jehan et al., 2020). Another factor that may contribute is the habit of consuming high-calorie, low-nutrient foods that often accompany a sedentary lifestyle. Therefore, it is important to encourage behavioral changes in terms of diet and daily activities.

Cardiovascular endurance is an important indicator of physical fitness. The study found

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that a sedentary lifestyle was negatively related to cardiovascular endurance, which was measured through physical fitness tests. Individuals with sedentary lifestyles showed lower VO2 max values than physically active individuals. These findings are in line with the results of a study from (Kraus et al., 2019), which found that lack of physical activity leads to decreased cardiovascular function due to weakening of the heart muscle and decreased body oxygen capacity. Decreased cardiovascular endurance in individuals with a sedentary lifestyle can also be explained through changes in the body's metabolism. According to research (Paterson et al., 2020), prolonged sitting time contributes to decreased blood flow and tissue oxygenation pressure, thereby worsening cardiovascular performance. In addition, a sedentary lifestyle is also associated with increased blood pressure, insulin resistance, and systemic inflammation, all of which can impair heart and blood vessel function (Sofra & Badami, 2020).

This study reinforces previous findings that sedentary lifestyle is a major risk factor for obesity and cardiovascular disorders. Researchers mention that low physical activity and high sitting time are identified as strong predictors of increased mortality due to cardiovascular disease (Dunstan et al., 2021; Kraus et al., 2019). In addition, research (Loh et al., 2020) highlights the importance of sedentary interruption patterns in improving metabolic and cardiovascular health. However, the study also makes a new contribution by highlighting certain populations, such as office workers, who are at high risk of experiencing sedentary lifestyle-related problems. This is relevant to today's global trends, where many individuals spend most of their time in front of computer screens, both for work and entertainment. Simple lifestyle changes, such as walking for 30 minutes a day can have a significant impact on BMI and cardiovascular endurance. For example, studies (Credeur et al., 2019) show that reducing sitting time to 2-3 hours per day can improve cardiovascular capacity and significantly reduce BMI. In the long run, this pattern not only impacts physical health but also mental well-being, as a sedentary lifestyle is often associated with stress and anxiety.

Theoretically, these findings support a sedentary behavior theory that states that the duration of passive activity has a direct impact on metabolic and cardiovascular health. These findings also reinforce the view that reducing sedentary time should be an integral part of obesity prevention strategies and the promotion of cardiovascular health in adolescents. This research has several limitations that need to be considered. First, data collection was carried out with a cross-sectional approach, so it was not possible to identify a causal relationship between sedentary lifestyle, BMI, and cardiovascular endurance. Second, sedentary lifestyle data was obtained through the IPAQ questionnaire, which relied on the respondents' ability to remember their activities. This can lead to recall bias and affect the accuracy of the results.

4. CONCLUSION

This study aims to analyze the influence of sedentary lifestyle on body mass index (BMI) and cardiovascular endurance in adolescents. The results showed that a sedentary lifestyle had a significant influence on these two variables. Increased sedentary time is positively correlated with an increase in BMI, which can increase the risk of overweight and obesity. In contrast, a sedentary lifestyle has a negative influence on cardiovascular endurance, where an increase in sedentary time leads to a decrease in cardiovascular endurance score. These findings highlight the importance of reducing sedentary time and increasing physical activity to maintain adolescent health, both in terms of weight management and cardiovascular ability. Therefore,

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interventions from families, educational institutions, and the community are needed to encourage healthy lifestyle habits, such as moving more, reducing sitting time, and increasing regular physical activity. Further research is recommended to use larger sample sizes, consider other factors such as diet and genetics, and develop a longitudinal design to understand the long-term impact of sedentary lifestyles. In addition, intervention-based research can be conducted to evaluate the effectiveness of sedentary time reduction programs on adolescent health holistically. These findings are expected to be the basis for the development of health policies focused on preventing overweight and lowering cardiovascular endurance from an early age.

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