Original Article

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Comparison of physical fitness based on sedentary lifestyle levels in adolescents: A comparative analysis

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Abstract

Background and Purpose: Physical fitness (PF) and sedentary lifestyles among adolescents have been extensively studied, but comprehensive research comparing differences in PF based on sedentary lifestyle levels remains limited. This study aims to analyze differences in PF based on sedentary lifestyle categories (low, moderate, and high) and compare PF between male and female adolescents. Methods: This comparative study used a one-way ANOVA design. A total of 90 adolescents (38 males, age 17.03±0.91 years; 52 females, age 16.94±1.07 years) were randomly recruited and classified into three sedentary lifestyle groups based on the results of measurements using the Adolescent Sedentary Activity Questionnaire (ASAQ): low (n_1=30), moderate (n_2=30), and high (n_3=30). PF was measured using the Indonesian Physical Fitness Test for ages 16–19 years. Data analysis was performed using one-way ANOVA and Tukey's post hoc test. *Results:* The results showed significant differences in PF scores between sedentary lifestyle groups (p=0.001), with the low sedentary lifestyle group having the highest PF score (mean=16.60) compared to the moderate (mean=14.30) and high (mean=10.40) sedentary groups. No significant difference was found between the PF of male and female adolescents (p=0.109). *Conclusions:* These findings confirm that a less sedentary lifestyle is associated with better PF in adolescents, while gender does not significantly affect PF levels. Therefore, strategies to reduce sedentary behavior need to be a primary focus in efforts to improve adolescent PF, particularly in Indonesia.

Keywords: physical fitness; physical activity; lifestyle; sedentary; adolescents

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INTRODUCTION

Physical fitness (PF) is a key indicator that plays an important role in supporting daily activities, supporting optimal development, and improving quality of life, especially during adolescence. Adolescence is considered a critical phase in physical and mental development, where PF status has long-term implications for health into adulthood [1–4]. PF contributes to weight control, improved cardiovascular function, and the prevention of various chronic diseases [5–9]. A number of studies also show that adolescents with higher levels of fitness tend to have better health status compared to less fit adolescents [3,10,11].

One of the main factors contributing to the decline in PF among adolescents is a sedentary lifestyle, which is the habit of sitting or lying down for long periods of time with minimal physical activity [12,13]. The development of digital technology has also contributed to this trend through activities such as watching television, playing with gadgets, and using computers [14,15]. Globally, it is estimated that around 80% of adolescents do not meet the WHO recommendation of at least 60 minutes of moderate to vigorous physical activity every day [16, 17]. This condition has a serious impact on public health, with the global economic burden projected to reach USD 300 billion by 2030 [18].

In Indonesia, Riskesdas data shows that 42% of children over the age of 10 spend 3–6 hours per day on sedentary activities. In addition, 49.6% of adolescents aged 15–19 years are recorded as having low levels of physical activity [19]. A sedentary lifestyle has been identified as an independent risk factor contributing to decreased PF, as well as increasing the risk of metabolic disorders and mental health problems [20]. High sedentary duration shows a negative relationship with PF capacity and is consistently associated with an increased prevalence of obesity, metabolic syndrome, and psychological disorders, both in preschool children and adolescents [12,21–23].

Although many studies have explored the relationship between sedentary lifestyles and PF [24–26], most have not explicitly compared PF based on sedentary lifestyle levels (low, moderate, and high). As a result, understanding of the specific impact of each sedentary lifestyle category on PF remains limited. For example, a study by Fadillah et al. [26] examined this relationship in adolescents aged 16–19 years and recommended school- and family-based interventions, such as integrating light to moderate physical activity into daily routines, limiting screen time, and promoting enjoyable physical activities to improve PF and prevent chronic diseases. Furthermore, most previous studies tended to assess only one or two components of PF, such as cardiovascular fitness, without considering other components such as muscle strength, muscle endurance, flexibility, and body composition, which also determine overall PF status [27]. Therefore, research comparing PF based on sedentary lifestyle categories is important to provide a more comprehensive overview.

In addition, gender is also an important variable that needs to be considered in studies of PF in adolescents. A number of studies have shown that adolescent boys generally have higher levels of PF than adolescent girls [28–30]. Rosselli et al. [30] reported that adolescent girls face psychological and social barriers, such as low energy and motivation, which impact their participation in physical activities and lead to decreased PF. These psychosocial factors contribute to the gender gap in PF, but most studies have not explicitly linked sedentary lifestyles to these differences.

Vilhjalmsson and Kristjansdottir [28] also noted that adolescent girls' participation in sports clubs tends to be lower than that of adolescent boys, which also explains the gender differences in physical activity. However, the study did not highlight the contribution of sedentary lifestyles in the context of modern lifestyles. Although many global studies have been conducted on the relationship between sedentary lifestyles and PF in adolescents, research specifically focusing on the Indonesian adolescent population is still very limited. In fact, national data from Riskesdas shows that nearly 50% of Indonesian adolescents aged 15–19 years have low levels of physical activity [19]. On the

other hand, previous studies have generally used accelerometers to assess PF, which are not always applicable in the Indonesian educational setting due to resource limitations. Therefore, the evaluation of PF that will be conducted through the Indonesian Physical Fitness Test offers a relevant and standardized approach in the local context, where the test consists of five subtests that must be performed sequentially: short-distance running, pull-ups, sit-ups, vertical jumps, and middle-distance running [4].

The purpose of this study was to obtain new knowledge regarding differences in PF among adolescents based on sedentary lifestyle (low, moderate, and high), as well as to compare PF between male and female adolescents. The results of this study are expected to contribute practically to the design of school- and family-based interventions to increase physical activity, reduce sedentary lifestyles, and encourage sustainable improvements in adolescent PF, particularly in Indonesia. The hypotheses in this study are (1) there are significant differences in PF between adolescents with low, moderate, and high sedentary lifestyles, and (2) there are no significant differences in PF between male and female adolescents.

MATERIAL AND METHODS

Study design

This study is comparative in nature, using a one-way ANOVA design to test the differences in mean values between three groups of variables. The variables compared are PF based on sedentary lifestyles (low, moderate, and high) in adolescents and how PF differs between male and female adolescents.

Participants

A total of 90 adolescents were involved in this study (see Figure 1), consisting of males (n_1=38, age 17.03±0.91 years, height 164.22±5.16 cm, weight 55.75±8.48 kg, and BMI 20.68±3.14) and females (n_2=52, age 16.94±1.07 years, height 156.92±5.21 cm, weight 51.12±7.97 kg, and BMI 20.83±3.68). Participants were tenth and eleventh grade students from senior high schools in Indonesia who took combined physical education classes, were physically healthy, participated voluntarily, and complied with the rules during the research activities. This study obtained ethical approval from the Faculty of Sports Science, Universitas Negeri Padang (No. 7522/UN35.3/PG/2022), and the West Sumatra Education Office, Indonesia (No. 7522/UN35.3/PG/2023).

Procedure for grouping based on sedentary lifestyle level

From an initial population of 250 students, all participants first underwent a sedentary lifestyle assessment using the Adolescent Sedentary Activity Questionnaire (ASAQ). Based on the assessment results, participants were categorized into three groups: low (n_1=33), moderate (n_2=62), and high (n_3=155). Participants were then randomly recruited by lottery based on low, moderate, and high sedentary lifestyle levels, with 30 participants in each group (see Figure 1). This randomization was applied to minimize selection bias, maintain balance between groups, and increase the validity of the research results. After grouping, participants' PF was analyzed based on sedentary lifestyle levels and compared between male and female participants.

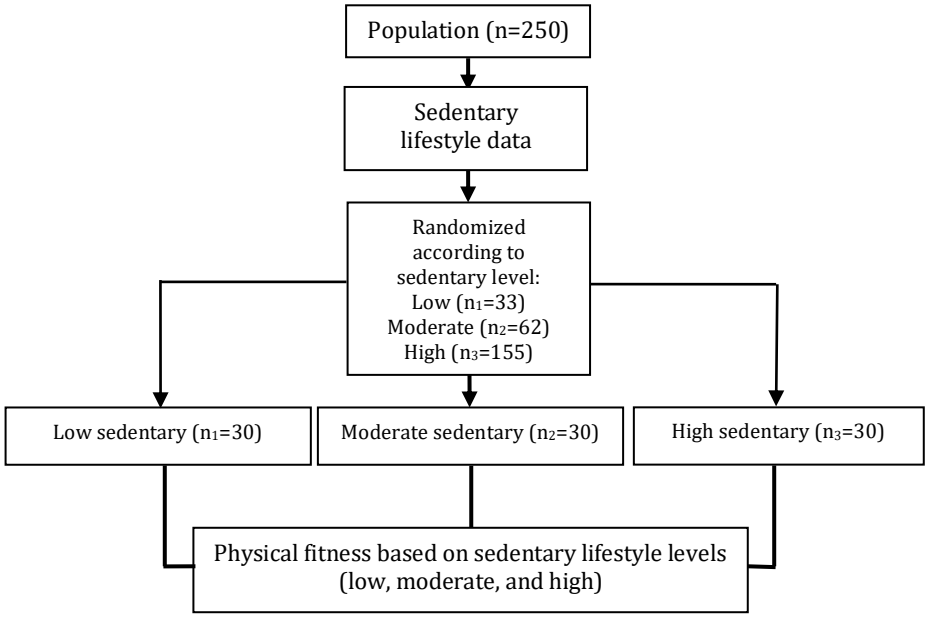

Figure 1. Participant recruitment procedure

Instruments

Sedentary lifestyle

Sedentary lifestyle was measured using the adapted ASAQ questionnaire [30]. This questionnaire covers eight domains of sedentary activities performed in a week, including watching TV, using a computer or smartphone, sitting or lying down while listening to music, sitting while reading, doing housework, playing musical instruments, creating artwork, and sitting while in a means of transportation (see appendix). The reliability of this instrument has been retested with a correlation coefficient of r=0.847. Classification was based on average daily time, with classifications of less than 2 hours (low), 2 to 5 hours (moderate), and more than 5 hours (high).

The questionnaire was completed in the classroom under the direct supervision of the researcher. Standard instructions were given verbally and in writing to ensure participants' understanding of the questionnaire items. Participants were asked to independently and honestly fill out a report of their sedentary activities for the past seven days. The completion time was 15–20 minutes, and the questionnaires were checked immediately for completeness and data consistency.

Physical fitness test

PF is measured using the Indonesian Physical Fitness Test for children aged 16-19 years [32]. This test is a standard test used to measure PF levels in the Indonesian population [4, 33]. The test consists of five subtests that must be performed in sequence: short-distance running, pull-ups, sit-ups, vertical jumps, and middle-distance running (Table 1). Classification to determine participants' PF levels was obtained from the total scores of the five subtests, namely scores of 22-25 (very good), 18-21 (good), 14-17 (moderate), 10-13 (poor), and 5-9 (very poor) [4].

All tests were conducted on the school field in the morning (07:00–09:30 WIB) in sunny or cloudy weather (27–30°C). This time was chosen to minimize excessive heat exposure that could affect the participants' physical performance. Participants were asked not to engage in strenuous physical activity the day before and to warm up for approximately 10 minutes before the test. All equipment was calibrated beforehand, and the tests were conducted by trained examiners. Scores were recorded immediately to ensure data accuracy.

Table 1. Types of physical fitness tests and assessments

Male					
Short-distance running (60 m)	Pull-ups	Sit-ups	Vertical jump	Middle-distance running (1.200 m)	Score
≤ 7.3”	≥ 18	≥ 40	≥ 72	≤ 3’15”	5
7.3–8.3”	14–18	30–40	60–72	3’15”–4’25”	4
8.4–9.6”	09 –13	21–29	50–59	4’26”–5’12”	3
9.7–11.0”	05–08	10–20	39–49	5’13”–6’33”	2
≥ 11.0”	00–04	00–09	≤ 39	≥ 6’33”	1
Female					
Short-distance running (60 m)	Hang with bent elbows	Sit-ups	Vertical jump	Middle-distance running (1.000 m)	Score
≤ 8.5”	≥ 40”	≥ 28	≥ 49	≤ 3’53”	5
8.5”–9.8”	22”–40”	20–28	39–49	3’53”–4’56”	4
9.9”–11.4”	10”–21”	10–19	31–38	4’57”–5’58”	3
11.5”–13.4”	03”–09”	03–09	23–30	5’59”–7’23”	2
≥ 13.4”	00”– 02”	00–02	≤ 23	≥ 7’23”	1

Note: Short-distance running (time measured in seconds), pull-ups (number of pull-ups the participant can perform), hang with bent elbows (time measured in seconds while maintaining the hang with bent elbows position), sit-ups (number of sit-ups the participant can perform), vertical jump (difference between the highest jump and the standing reach measured in centimeters), and middle-distance running (time measured in minutes).

Statistical analyses

The data were analyzed using SPSS version 28.0 by presenting descriptive statistics, analysis requirements tests, ANOVA, and independent sample t-tests. Normality tests were performed using Shapiro-Wilk and showed normal data distribution (ANOVA: $W_{s.low}$=0.967/p=0.45; $W_{s.moderate}$=0.940/p=0.09; $W_{s.high}$=0.934/p=0.06; and t-test: W_{male}=0.930/p=0.07; W_{female}=0.942/p=0.07). Meanwhile, Levene's test showed that the variance between groups was homogeneous (ANOVA: $Fs_{.low}$=0.083/p=0.92; $F_{s.moderate}$=0.065/p=0.93; $F_{s.high}$=0.083/p=0.92; and t-test: F_{male}=0.085/p=0.91; F_{female}=0.086/p=0.93). ANOVA was used to analyze differences in PF means based on sedentary lifestyle categories (low, moderate, and high), because there were more than two groups being compared and the data met the parametric assumptions. Meanwhile, the independent samples t-test was used to test differences in PF based on gender, because it only involved two independent groups (male and female). The selection of these two tests was based on the characteristics of the data and the fulfillment of the assumptions of normality and homogeneity. To support the interpretation of the results, effect sizes were calculated using eta square (η^2) and Cohen's d.

RESULTS

Descriptive analyses of sedentary lifestyle data yielded an average of 111.67 for low sedentary lifestyle, 272.30 for moderate sedentary lifestyle, and 445.53 for high sedentary lifestyle (Figure 2). Meanwhile, the physical fitness (PF) data indicated an average score of 16.60 for adolescents with a low sedentary lifestyle, 14.30 for those with a moderate sedentary lifestyle, and 10.40 for those with a high sedentary lifestyle. Furthermore, the mean PF score was 14.42 for male adolescents and 13.29 for females (Table 2). The ANOVA results revealed significant differences in PF according to sedentary lifestyle level (low, moderate, and high) among adolescents (F=66.995, p=0.001, η^2=0.606).

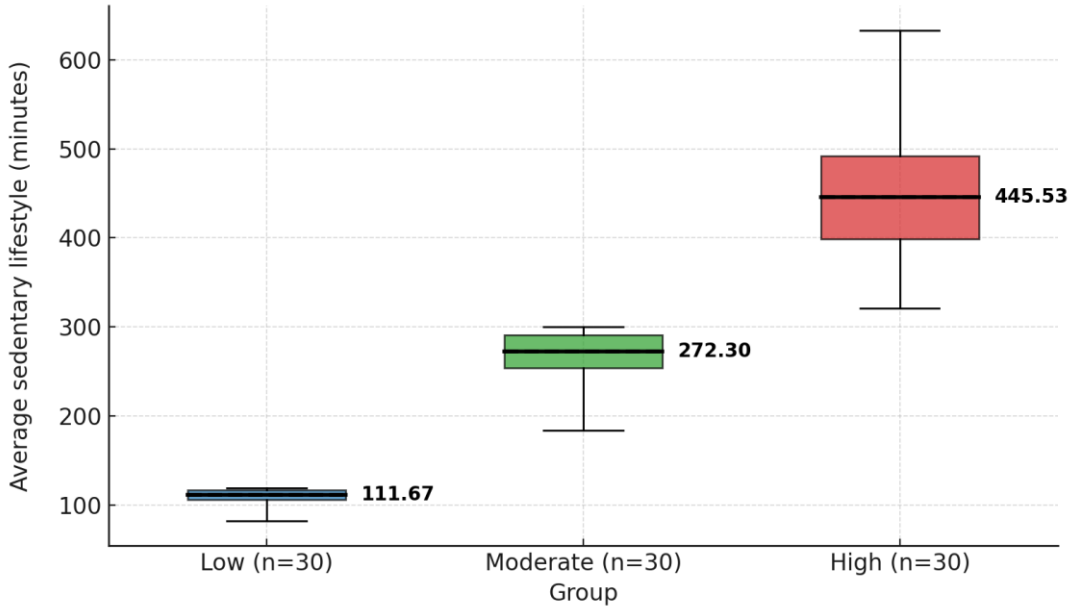

Figure 2. Graphical descriptive analysis of sedentary lifestyle data (total reports provided by respondents for each item; in minutes).

Table 2. Description of physical fitness data based on sedentary lifestyle

Data	Source	Sedentary lifestyle			Statistics
		Low (n_1=30)	Moderate (n_2=30)	High (n_3=30)	
Physical fitness	Min	12.00	11.00	7.00	F=66.995; p<0.001; η^2=0.606
	Max	20.00	18.00	14.00	
	M	16.60	14.30	10.40	
	SD	2.06	2.18	2.04	
	Range	8.00	7.00	7.00	
Fitness classification		Moderate	Moderate	Poor	

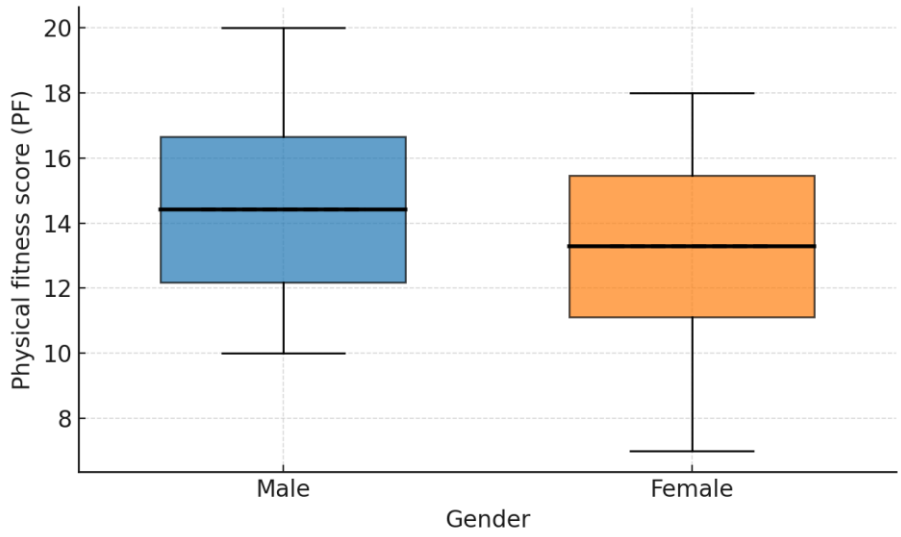

Figure 3. Physical fitness by gender (p=0.109; d=0.345)

Table 3. Tukey's post hoc comparisons of physical fitness between sedentary lifestyle levels

Comparison (I–J)	Mean Difference (I–J)	Std. Error	p-value	Interpretation
Low – Moderate	2.30*	0.54	<0.001	Low > Moderate
Low – High	6.20*	0.54	<0.001	Low > High
Moderate – High	3.90*	0.54	<0.001	Moderate > High

To determine which level of PF is better based on the level of sedentary lifestyle, a post hoc analyses was conducted. Based on Table 3, it shows that a low sedentary lifestyle has better PF compared to moderate and high sedentary lifestyles. This can be seen from the average scores, where PF for a low sedentary lifestyle has an average of 16.60, a moderate sedentary lifestyle is 14.30, and a high sedentary lifestyle is 10.40. In addition, an independent samples t-test showed that there was no significant difference in PF between male and female adolescents (p=0.109; Cohen's d = 0.345), with an average PF of 14.42 for males and 13.29 for females (figure 3).

DISCUSSION

The main findings show that adolescents with a low sedentary lifestyle have significantly higher PF scores than those in the moderate and high sedentary groups. ANOVA revealed the highest mean PF scores in the low sedentary group (M=16.60), followed by the moderate group (M=14.30), and the lowest in the high sedentary group (M=10.40), with highly significant differences ($p<0.001$; $\eta^2=0.606$). Post hoc Tukey confirmed that each group was significantly different. Conversely, the t-test showed no significant difference between the PF of male and female adolescents (p=0.109; d=0.345), although males tended to have slightly higher scores (M=14.42 vs M=13.29), but this difference was not statistically significant.

The scientific contribution of this study is empirical confirmation in the Indonesian context that a sedentary lifestyle is inversely related to PF levels, while gender is not a dominant factor. These findings highlight the need for policy approaches that not only encourage physical activity but also actively reduce passive sitting time, especially in Indonesian school environments that are saturated with classroom-based academic activities [33].

Although these findings are consistent with the studies by Fadillah et al. [26] and Pojskic and Eslami [29], this study provides added value by presenting evidence from the local Indonesian population using measurement tools such as the Indonesian Physical Fitness Test [4, 33]. This context is important, given that many previous studies have come from developed populations with different educational structures and lifestyles [34]. In Indonesia, students tend to spend more than 8 hours per day on static learning activities, both at school and through homework, which exacerbates their daily sedentary levels [4]. Therefore, these findings can serve as an evaluation for schools and education policymakers.

Furthermore, this study highlights that despite the common assumption that male adolescents tend to be more physically active, there is no significant difference in PF scores based on gender. These results reinforce the findings of Vilhjalmsson and Kristjansdottir [28], but in the Indonesian context, they show that barriers to physical participation are not biological factors but are most likely caused by limited access to quality sports programs and space for movement in the school environment [26]. This indicates the need for inclusive school-based interventions for all genders, rather than relying on extracurricular activities or participation in sports clubs.

The decline in PF with increasing sedentary time is supported by research by Dong et al. [15], Santos et al. [35], and Júdice et al. [12]. However, this study adds the context that the impact of a sedentary lifestyle in Indonesia may be worse due to the lack of

balance between formal learning and physical activity. In fact, physical education classes in many schools only take place once a week and are sometimes canceled due to academic activities [33]. Thus, these findings support the need to integrate light physical activity into regular classes.

These findings further emphasize the urgency of active involvement by schools and parents in creating an environment that supports regular physical activity for children and adolescents. Interventions can be implemented through the integration of quality physical education programs and the provision of active recreational activities as preventive measures against the negative effects of a sedentary lifestyle. A study by Dumuid et al. [21] emphasizes that sedentary behavior cannot be separated from other daily activities. Reducing sedentary time without shifting it to physiologically active activities—such as sports or active play—will not provide significant benefits for PF. Therefore, it is important to ensure that time previously spent on passive activities is shifted to moderate- to high-intensity physical activities.

The measurement of sedentary lifestyles in this study used ASAQ [26,36], and PF evaluation used the Indonesian Physical Fitness Test [4,33], which offers a relevant and standardized approach in the local context. This distinguishes it from many global studies that generally use accelerometers, which are not always applicable in the Indonesian educational setting due to resource limitations.

Although these findings highlight that the level of sedentary lifestyle has a significant effect on adolescent PF, the limitations of this study need to be reported. Data were obtained through the ASAQ self-report questionnaire, which is prone to reporting bias and subjective interpretation of activity duration by respondents. This study only involved 90 adolescents from a geographically and demographically limited population, so the findings need to be generalized to a broader adolescent population in future studies. Although both genders were represented, not all factors that could influence PF, such as nutritional status, extracurricular participation, and socioeconomic status factors, were comprehensively analyzed. Longitudinal studies, objective measurement methods, and more complex data analysis are needed for future research.

CONCLUSION

This study shows that a sedentary lifestyle has a significant effect on adolescents' PF, where the lower the level of sedentary behavior, the higher the PF score achieved. Adolescents in the low sedentary category had a significantly higher average PF score (16.60) than those in the moderate (14.30) and high (10.40) sedentary categories. This confirms that reducing passive physical activity, such as sitting for too long without physical activity, needs to be a major concern in strategies to improve adolescent PF. Meanwhile, the results of this study did not show significant differences in PF between male and female adolescents, indicating that gender differences are not a major determinant at this age. Therefore, efforts to improve PF should be inclusive, not differentiated by gender, but based on daily activity habits. The practical implications of these results are highly relevant in the context of Indonesian education, where learning patterns that require prolonged sitting and a lack of integration of physical activity outside of physical education classes are still common. Structured interventions from schools, families, and communities are needed to create an environment that supports an active lifestyle. This can be achieved through strengthening meaningful physical education, reducing sitting time in school routines, and facilitating attractive and sustainable physical activities both inside and outside of school. As an initial contribution to the issue of PF among adolescents in Indonesia, these findings highlight the need for evidence-based policies that focus on reducing sedentary behavior as a key strategy for improving PF. Further research using a longitudinal approach and objective measurements is needed to reinforce these findings and develop more contextually effective interventions.

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Conflicts of Interest: The authors declare no conflict of interest.

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Appendix

The response options in the ASAQ include sedentary activities performed over one week

Items	Day (Monday-Sunday)	
	Hours	Minutes
Watching TV, YouTube, Netflix, anime, dramas, or other types of film series.		
Using a computer or smartphone (social media, playing online or offline games).		
Sitting or lying down while listening to music.		
Sitting while reading books, novels, comics (electronic or non-electronic).		
Doing homework.		
Playing musical instruments.		
Doing art stuff like drawing, crafts, and that sort of thing.		
Sitting on a means of transportation or driving a vehicle.		