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Comparison of Physical Fitness Between Stunted and Normal Stature Adolescents

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Abstrak

Stunting merupakan bentuk malnutrisi kronis yang tidak hanya menghambat pertumbuhan linear, tetapi juga dapat menurunkan kapasitas fisik remaja. Penelitian cross-sectional ini bertujuan membandingkan tingkat kebugaran jasmani remaja usia 13–15 tahun yang mengalami stunting dan berperawakan normal di sebuah SMP di Kabupaten Mukomuko, Bengkulu. Sebanyak 200 remaja (101 laki-laki dan 99 perempuan) dilibatkan dalam penelitian. Kebugaran jasmani diukur menggunakan Tes Kebugaran Jasmani Indonesia (TKJI), aktivitas fisik dinilai dengan PAQ-A, dan status tinggi badan menurut umur ditentukan menggunakan WHO AnthroPlus. Hasil menunjukkan bahwa kelompok berperawakan normal memiliki skor kebugaran rata-rata lebih tinggi (14,3 ± 2,3) dibandingkan kelompok stunting (12,6 ± 2,4). Remaja stunting memiliki risiko 3,25 kali lebih besar mengalami kebugaran rendah (OR = 3,25; 95% CI: 1,617–6,550; p < 0,05). Analisis regresi menunjukkan tinggi badan berkontribusi signifikan terhadap variasi skor kebugaran sebesar 9,4% (p < 0,05). Temuan ini mengindikasikan bahwa dampak stunting tidak hanya terbatas pada aspek antropometri, tetapi juga memengaruhi kapasitas fungsional. Oleh karena itu, diperlukan integrasi intervensi gizi dan program kebugaran fisik dalam Usaha Kesehatan Sekolah (UKS) untuk mengurangi dampak jangka panjang stunting pada kualitas sumber daya manusia.

Keywords:
Physical activity
Physical fitness
Stunting sufferers
Adolescents
Stunting

Abstract

Stunting is a manifestation of chronic malnutrition that not only inhibits linear growth but also potentially impairs musculoskeletal development and functional body capacity, yet research on its impact on the physical performance of adolescents remains limited. This cross-sectional comparative study aimed to assess and compare physical fitness levels among stunted and normal-height adolescents aged 13–15 years at a junior high school in Mukomuko, Bengkulu, involving 200 subjects (101 males, 99 females). Physical fitness was measured using the Indonesian Physical Fitness Test (TKJI)—comprising sprints, pull-ups, sit-ups, vertical jumps, and middle-distance running—while activity levels were assessed via the PAQ-A and height-for-age evaluated using WHO AnthroPlus. The results showed that normal-height adolescents had significantly higher mean fitness scores (14.3 ± 2.3) compared to the stunted group (12.6 ± 2.4), with stunted adolescents exhibiting a 3.25 times higher risk of low physical fitness (OR 3.25; 95% CI: 1.617–6.550; P < 0.05). Regression analysis further revealed that height accounted for 9.4% of the variance in fitness scores (p < 0.05), emphasizing that stunting impacts extend beyond anthropometric deficits to broader functional impairments. These findings highlight an urgent need for integrating structured physical fitness programs and specific nutritional interventions into School Health Services (UKS) to mitigate long-term impacts on human resource quality and adult productivity, while further research is warranted to explore the underlying biological mechanisms.

Introduction

Stunting is a common problem frequently encountered by pediatricians. This condition occurs when children fail to achieve their maximum height potential for their age due to chronic malnutrition, recurrent infections, and inadequate stimulation. Disruptions at any stage of these processes can adversely affect growth, resulting in stunting, which is defined as a height that is more than two standard deviations below the average height for age and sex within the same ethnic group (Mulyani et al., 2025). According to the 2023 Indonesian Health Survey data, the national prevalence of stunting among adolescents aged 13–15 years remains significant, reaching 16.7% in males and 18.4% in females. The incidence of stunting in the 13–15-year age group is considerably higher compared to other child age groups. Nationally, the prevalence of stunting among children aged 5–12 years is 14.1%, while the prevalence among adolescents aged 13–15 years and 16–18 years is 17.5% and 20.1%, respectively (Kementerian Kesehatan Republik Indonesia, 2023).

Optimal nutritional status plays an important role in supporting muscle development, body endurance, and adolescents' physical capacity in performing daily activities and sports. Adolescents experiencing chronic malnutrition, such as stunting, may experience significant impairments in muscle mass development and cardiovascular capacity, which ultimately reduce physical performance, limit motor function, and create functional limitations due to disproportionate anthropometric dimensions (Akbar et al., 2023). Biologically, individuals with stunting tend to have lower muscle fiber density and impaired energy metabolism efficiency, thereby increasing their susceptibility to physical fatigue (Mchau et al., 2024). In fact, physical fitness, which includes muscular strength and systemic endurance, is an important determinant for adolescents in maintaining health homeostasis (Pérez-Ramírez et al., 2024).

Although many studies on stunting have been conducted, most research has focused on the impact of stunting on cognitive development, academic achievement, and the health of children under five years old (Gusnedi et al., 2023; Haskas, 2020; Nirmalasari, 2020). Studies specifically examining the relationship between stunting and physical fitness among adolescents remain relatively limited, particularly in Indonesia. Research comparing the physical fitness levels of stunted adolescents and adolescents with normal growth using standardized national fitness instruments is still scarce. This lack of data has resulted in an incomplete understanding of the long-term effects of stunting on adolescents' physical capabilities, even though adolescence represents a critical transitional phase toward productive adulthood. The findings of this study are expected to serve as a basis for developing more targeted nutrition and physical activity intervention programs for adolescents, particularly within school environments. Furthermore, the results are expected to support government efforts to reduce the long-term impacts of stunting and improve the quality of Indonesia's human resources in the future.

Methods

This study employed a comparative cross-sectional design conducted among junior high school students in Mukomuko, Bengkulu, Indonesia. Subjects were selected using a simple random sampling technique between January and May 2018. Prior to data collection, written informed consent was obtained from the parents or guardians of the participants. This study received ethical approval from the Ethics Committee of the Faculty of Medicine, Universitas Sriwijaya before the research was conducted. All research procedures were carried out in accordance with the ethical principles of health research, including providing research information and obtaining participants' consent. The study subjects were adolescents aged 13–15 years who met the inclusion criteria, namely being in good health, having no comorbid conditions such as heart disease, musculoskeletal disorders, or exercise-induced asthma, and having completed the entire series of physical fitness tests established in this study.

The sample size for this study was determined using a formula for cross-sectional studies based on population proportions (Dahlan, 2014). The calculation incorporated Zα value of 1.96, a stunting prevalence (P) of 0.743, a Q value of 0.257, and a precision level (d) of 5–10%. Based on these parameters, the minimum required sample size was identified as 73–156 subjects. To enhance the statistical power and minimize potential bias, this study enrolled a total of 200 adolescents. A simple random sampling technique was employed for subject selection. Respondents were chosen through a randomization process based on student attendance lists, followed by verification of their presence during the data collection period. This technique was utilized to ensure that every individual within the target population had an equal probability of being selected for the study.

Height was measured using a stadiometer with a capacity of 200 cm and a precision of 0.1 cm. During the measurement process, respondents were required to remove footwear and head accessories to ensure data accuracy. Height-for-age status was assessed based on the WHO growth standards using the WHO AnthroPlus software version 1.0.4. WHO AnthroPlus is a globally recognized tool designed to apply the 2007 WHO growth references for children and adolescents aged 5–19 years. Adolescents were categorized as stunted if their height-for-age z-score (HAZ) was less than -2 standard deviations (SD) (WHO, 2015).

Adolescent physical activity levels were assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A). This instrument is a self-administered questionnaire with a seven-day recall period, designed to evaluate participation in various physical activities, including those during physical education classes, recess, after school, evenings, and weekends (Kowalski et al., 1997; 2004). Each item on the PAQ-A is scored on a scale of 1 to 5, with higher scores indicating higher levels of physical activity. The total PAQ-A score is derived from the mean value of all items. Physical activity levels were further categorized into physically active (scores 3–5) and low activity (scores 1–2). The ninth item of the PAQ-A was utilized to identify specific conditions, such as illness or other barriers that may have affected the respondent's physical

activity during the past week; however, this item was excluded from the final total score calculation.

Physical fitness was measured using the Indonesian Physical Fitness Test (Tes Kebugaran Jasmani Indonesia or TKJI) for adolescents aged 13–15 years. This instrument has a reported reliability of 0.911 for males and 0.942 for females, with validity scores of 0.884 and 0.897, respectively (Nurhasan, 2007) . The test components include a 50-meter sprint, pull-ups, sit-ups, vertical jumps, and middle-distance running (800 meters for females and 1000 meters for males). Each component is assigned a score ranging from 1 to 5, which is then summed to obtain a total physical fitness score. The total scores are categorized as follows: excellent (22–25 points), good (18–21 points), average (14–17 points), fair (10–13 points), and poor (5–9 points). Furthermore, physical fitness was classified into two broad categories: fit (14–25 points) and unfit (5–13 points). All physical fitness assessments in this study were conducted by two experienced physical education teachers who were formally trained in the TKJI protocols.

Statistical analyses in this study included both univariate and bivariate analyses. Univariate analysis was performed to describe the characteristics of the study subjects. Bivariate analysis was conducted using chi-square tests, independent t-tests, Pearson correlation, and regression analysis. The independent t-test was employed to compare physical activity levels and physical fitness scores between stunted and normal-height adolescents. Pearson correlation was used to analyze the relationship between height-for-age and physical fitness. Regression analysis was performed to identify factors influencing adolescent physical fitness. A p-value < 0.05 was considered statistically significant. All data analyses were executed using SPSS software version 22.0 for macOS.

Result dan Discussion

Physical and sociodemographic characteristics

There were 200 adolescents consisting of 101 (50.5%) males aged 13.67+0.69 years old and 99 (49.5%) females aged 13.67+0.68. Female participants were heavier, shorter, and had lower physical fitness scores than male participants. Most participants had low parental educational backgrounds and economic status. The percentage of physically active and fit participants was higher among males, whereas most females were less physically active and non-fit. The physical and sociodemographic characteristics of the study participants are reported in Table 1.

Tabel 1. Physical and sociodemographic characteristics of study participants

Characteristics	Male (n=101) Mean (SD)	Female (n=99) Mean (SD)
Age (years old)	13.67 (0.69)	13.67 (0.68)
Body weight (Kg)	43.93 (9.46)	45.10 (7.86)
Body Height (m)	1.56 (0.08)	1.51 (0.05)
Physical fitness score	14.8 (2.4)	13.03 (2.1)

Characteristics	Male (n=101) Mean (SD)	Female (n=99) Mean (SD)
Stature-for-age, n(%)		
Stunted	19 (18.8)	26 (26.3)
Normal Stature	82 (81.2)	73 (73.7)
Physical activity, n(%)		
Less active	45 (44.6)	55 (55.6)
Active	56 (55.4)	44 (44.4)
Physical fitness, n(%)		
Nonfit	33 (32.7)	56 (56.6)
Fit	68 (67.3)	43 (43.4)
Father Educational Background, n(%)		
Low	67 (66.4)	59 (59.7)
Middle	25 (24.7)	34 (34.3)
High	9 (8.9)	6 (6)
Mother Educational Background, n(%)		
Low	67 (66.4)	56 (56.6)
Middle	17 (16.8)	32 (32.3)
High	17 (16.8)	11 (11.1)
Economic state, n(%)		
Low	64 (63.4)	75 (75.8)
Middle-High	37 (36.6)	24 (24.2)

Physical Activity

Table 2 shows the physical activity level in stunted and normal-stature adolescents. Among stunted adolescents, the percentage of physically active adolescents was higher than that of less active adolescents, at 55.6% and 44.4%, respectively. In normal-stature adolescents, the percentage of physically active adolescents was lower than that of less active adolescents, at 48.4% and 51.6%, respectively. This study showed that physical activity levels between stunted and normal-stature adolescents were not significantly different (OR 0.75; 95% CI 0.385-1.461; p>0.05). Stature did not show a correlation with Physical activity level (r -0.06, p>0.05).

Tabel 2. Physical Activity Level in stunted and normal-stature adolescents

Stature-for-age	Physical Activity Level		OR (95%CI)	p-value
	Less Active n (%)	Active		
Stunted	20 (44.4%)	25 (55.6%)	0.75 (95%CI 0.385-1.461)	0.397
Normal-Stature	80 (51.6%)	75 (48.4%)		

Physical Fitness

The average physical fitness score in stunted adolescents was lower than that in normal-stature adolescents, at 12.6+2.4 and 14.3+2.3 points, respectively. Table 3 shows the physical fitness of stunted and normal-stature adolescents. In stunted adolescents, the percentage of non-fit was higher than fit, at 66.7% and 33.3%, respectively. Meanwhile, among normal-stature adolescents, the percentage of nonfit was lower than that of fit, at 38.1% and 61.9%, respectively. This study showed that stunted adolescents had significantly lower physical

fitness than normal-stature adolescents (OR 3.25; 95% CI 1.617-6.550; P < 0.05). Stature was significantly correlated with physical fitness (r = 0.24, p < 0.05).

Tabel 3. Physical fitness in stunted and normal-stature adolescents

Stature-for-age	Physical Fitness		OR (95%CI)	p-value
	Nonfit	Fit		
	n (%)			
Stunted	30 (66.7%)	15 (33.3%)	3.25 (95%CI	0.001
Normal-Stature	59 (38.1%)	96 (61.9%)	1.617-6.550)	

Table 4 shows the physical fitness of less-active and active Adolescents. In physically less active adolescents, the percentages of non-fit and fit were lower than those of fit, at 47% and 53%, respectively. Also, among physically active adolescents, the percentage of non-fit was lower than that of fit, at 42% and 58%, respectively. This study showed that physical fitness between less-active and active Adolescents was not significantly different (OR 1.225; 95% CI 0.701-2.141; p>0.05). Physical activity level did not show a correlation with physical fitness (r 0.05, p>0.05)

Table 5 shows that stature had a significant impact on physical fitness (p<0.05). Apparently, 9.4% of the variance in physical fitness can be explained by stature variables. Each additional point of stature/age may improve physical fitness by 0.73%. Age, gender, and physical activity level did not significantly influence physical fitness (p>0.05)

Tabel 4. Physical fitness in physically less active and active adolescents

Physical Activity Level	Physical Fitness		OR (95%CI)	p-value
	Nonfit	Fit		
	n (%)			
Less Active	47 (47%)	53 (53%)	1.225 (95%CI	0.477
Active	42 (42%)	58 (58%)	0.701-2.141)	

Tabel 5. Factors Affecting Physical Fitness

Variable	B	Sig.
Constant	14.518	0.000**
Stature/age	0.731	0.000**
R^2	0.094	
F (Sig)	20.447 (0.000)	

**Significant in α = 1%

Correlation Between Growth Retardation and Physical Fitness Levels

The findings of this study demonstrate that stunted adolescents aged 13–15 years exhibit lower physical fitness levels compared to their normal-growth counterparts. The mean physical fitness score in the normal-growth group was significantly higher than that in the stunted group. Statistical analysis further revealed that stunted adolescents have a 3.25 times higher risk of having low physical fitness than non-stunted adolescents. Additionally, regression analysis

indicated that height significantly influences physical fitness, contributing 9.4% to the variability in physical fitness scores. These findings suggest that linear growth impairment in adolescents is not only manifested in anthropometric status but is also associated with reduced physical capacity and fitness performance (Ferozi et al., 2024).

The findings of this study are consistent with several previous investigations reporting that stunting contributes to diminished physical performance in children and adolescents (Ningrum et al., 2018; Santos et al., 2020; Scheffler & Hermanussen, 2025). Notably, although this study observed no significant difference in physical activity levels between the stunted and non-stunted groups, the physical fitness capacity of stunted adolescents remained significantly lower. This suggests that reduced physical fitness in stunted individuals may not be solely influenced by the frequency of physical activity, but rather by underlying physiological limitations resulting from long-term growth impairment (Soliman et al., 2021). Consequently, even when stunted adolescents maintain activity levels comparable to their normal-growth peers, their biological capacity to generate strength, endurance, and overall physical performance remains inferior to that of their normal-growth peers.

The decline in physical fitness among stunted adolescents can be elucidated through various biological and physiological mechanisms resulting from chronic malnutrition during growth periods. Prolonged nutritional deficiencies lead to impaired skeletal muscle development, a reduction in lean body mass, and atrophy of muscle fibers, particularly type II fibers, which are essential for muscular strength and explosive power (Jun et al., 2023). These conditions subsequently diminish the muscle's ability to generate force during physical exertion, affecting performance in components such as sprints, pull-ups, sit-ups, and vertical jumps utilized in the Indonesian Physical Fitness Test in this study. Furthermore, linear growth impairment also impacts the development of the cardiorespiratory system, including lung capacity and maximal oxygen uptake (VO_2 max), thereby reducing systemic endurance during physical activity (Deliceoğlu et al., 2024). Chronic energy deficits further contribute to impaired energy metabolism efficiency and increased lactate accumulation, which triggers premature physical fatigue in stunted adolescents (Das et al., 2017). The synergy of these various mechanisms is presumed to be the primary factor underlying the low physical fitness levels observed in stunted adolescents within this study.

Study Limitations

This study found no significant difference in physical activity levels between stunted adolescents and those with normal growth based on the Physical Activity Questionnaire for Adolescents (PAQ-A). Nevertheless, several limitations must be considered when interpreting these results. First, the cross-sectional design restricts the ability to establish a direct causal relationship between stunting and physical fitness or to observe long-term changes in fitness levels. Second, this study was conducted at a single school in Mukomuko Regency, Bengkulu; thus, the findings may not be generalizable to the broader adolescent population in Indonesia. Third, physical activity was assessed using a self-reported method (PAQ-A), which relies on the respondents' ability to recall activities over the past seven days. This method is susceptible to recall and reporting bias compared to objective instruments such as accelerometers. Furthermore, this study did not evaluate other potential confounding factors that may influence physical fitness in greater depth, such as daily nutritional intake, pubertal status, sleep quality, general health conditions, and body composition, including body fat percentage and specific

muscle mass. Incorporating these factors would provide a more comprehensive explanation of the mechanisms underlying reduced physical fitness in stunted adolescents.

Implications for Adolescent Health and Nutrition Programs

The findings of this study provide significant implications for adolescent health policies and programs in Indonesia. Stunting interventions should not be focused solely on linear growth recovery or height improvement, but must also consider the restoration of physical capacity and fitness. The finding that stunted adolescents exhibit lower physical fitness levels indicates that the impact of stunting is multidimensional, potentially affecting health quality and individual productivity in adulthood. Therefore, stunting management approaches should be more comprehensive, integrating nutritional interventions with structured physical activity programs.

Schools serve as a strategic environment for implementing promotive and preventive programs for adolescents, particularly through the integration of balanced nutrition education, routine physical activities, and student health monitoring. Given the high prevalence of stunting in the 13–15 age group, the government, through the education and health sectors, should consider integrating physical fitness screening into School Health Services (Usaha Kesehatan Sekolah or UKS). Furthermore, regular evaluations of nutritional status and physical fitness are essential for the early detection of growth impairments and reduced physical capacity. Follow-up interventions, comprising improved nutritional intake combined with targeted physical exercise programs such as light-to-moderate intensity resistance training, have the potential to help stunted adolescents enhance their muscle strength, physical endurance, and functional body capacity. These efforts are expected not only to improve adolescent physical fitness but also to support the enhancement of Indonesia's human resource quality, increase productivity in adulthood, and reduce the long-term risk of non-communicable diseases.

Conclusion

This study demonstrates that stunted adolescents aged 13–15 years exhibit significantly lower physical fitness levels compared to their normal-growth counterparts. Stunting is proven to be associated with a decline in physical capacity, including muscle strength, endurance, and overall physical performance. These deficits are likely influenced by impaired musculoskeletal development and cardiorespiratory limitations resulting from chronic malnutrition during critical growth periods. These findings underscore that the impact of stunting extends beyond linear growth impairment, affecting adolescent physical function and health in a broader context. Consequently, addressing stunting during adolescence is of paramount importance to prevent long-term consequences on physical capacity, productivity, and health quality in adulthood. Integrated interventions—comprising improved nutritional status, increased physical activity, and regular health monitoring—should be implemented early, particularly within the school environment. Such efforts are expected to enhance adolescent physical fitness, mitigate future health risks, and support the development of a healthier and more productive human resource.

Conflicts of interest

The authors declare no conflict of interest in this study.

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