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Effects of Stunting on the Decreased Cardiorespiratory Fitness of Children Aged 9 to 11 Years in Bandar Lampung, Indonesia

Efek Stunting terhadap Penurunan Kebugaran Kardiorespirasi pada Anak Usia 9-11 Tahun di Bandar Lampung, Indonesia

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Cardiorespiratory fitness; cardiovascular disease; Harvard step test; stunting in children.

Abstract
Introduction: The impact of low cardiorespiratory fitness levels can increase cardiovascular disease and other degenerative diseases. Children with stunting need attention to cardiorespiratory fitness levels. **Purpose:** This study aims to determine the effect of stunting on cardiorespiratory fitness in children aged 9-11 years. **Methods:** This type of research is observational analytic with a cross-sectional design. The sample of this study was 77 elementary school children who were taken using consecutive sampling techniques. Measurement of the research variable cardiorespiratory fitness level using the modified Harvard step test and the stunting variable measured using the child's Body Length/Height measurement index, stunting if the measurement is at the threshold of -3SD to < -2SD. The Spearman test analysed data. **Results:** A total of 77 children were found to be stunted, with a cardiorespiratory fitness level of 92.3% and a poor level of 7.7%. Meanwhile, children in the non-stunting category had 23.7% less cardiorespiratory fitness and no poor fitness. The results of the analysis show a relationship between stunting and cardiorespiratory fitness in children (p=0.0001), which is a very strong relationship (r=0.917). Conclusion: Stunting in children has a chronic effect on cardiorespiratory fitness. It is necessary to improve cardiorespiratory fitness in children with measurable physical exercise and improved micronutrients to prevent early health impact on adulthood.

Kata kunci:
Harvard step test; kebugaran kardiorespirasi; penyakit kardiovaskuler; stunting pada anak.

Abstrak
Latar Belakang: Dampak tingkat kebugaran kardiorespirasi yang rendah dapat meningkatkan penyakit kardiovaskular dan penyakit degenerative lain. Anak dengan stunting perlu mendapatkan perhatian tingkat kebugaran kardiorespirasi. **Tujuan**: Penelitian ini bertujuan untuk mengetahui efek stunting dengan kebugaran kardiorespirasi pada anak usia 9-11 tahun. **Metode:** Jenis penelitian ini bersifat analitik observasional dengan desain *cross sectional*. Sample penelitian ini adalah anak SD berjumlah 77 orang yang diambil menggunakan teknik consecutive sampling. Pengukuran variabel penelitian tingkat kebugaran kardiorespirasi mengunakan Harvard step test yang dimodifikasi dan variabel stunting diukur menggunakan indeks pengukuran PB/ TB anak, stunting jika pengukuran berada pada ambang batas -3SD sd < -2SD. Data dianalisis dengan uji Spearman. **Hasil:** Partisipan total 77 anak menemukan dengan kategori stunting yang mengalami kebugaran kardiorespirasi level kurang 92,3% dan level buruk 7,7%. Sedangkan, anak kategori tidak stunting terdapat anak dengan kebugaran kardiorespirasi kurang 23,7% dan kebugaran buruk tidak ditemukan. Hasil analisis menunjukkan terdapat hubungan stunting dengan kebugaran kardiorepirasi pada anak (p=0,001) dengan hubungan sangat kuat (r=0,917). **Simpulan:** Stunting pada anak memberikan pengaruh yang kronis pada penurunan kebugaran kardiorespirasi. Perlu meningkatkan tingkat kebugaran kardiorespirasi pada anak dengan latihan fisik yang terukur maupun peningkatan gizi mikro untuk mencegah sejak dini dampak Kesehatan pada masa dewasa.

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Introduction

Cardiorespiratory fitness (CRF) is part of the components of physical freshness that affect physical health and fitness, including in childhood, especially school children (Widiastuti et al., 2017), assessment of maximal oxygen consumption (VO2 max) and strong independent predictors of cardiovascular disease

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risk and mortality (Ezzatvar et al., 2021). It is currently seen as a meaningful, vital sign and valuable contribution to health and prognosis (Ozemek et al., 2018). A systematic review study found that better CRF status provided a lower predictor associated with a risk of death and cardiovascular disease (Ezzatvar et al., 2021). CRF, as stated by the American Heart Association, can provide additional prognostic value for cardiovascular disease (CVD) and mortality risk beyond traditional cardiovascular risk factors, such as hypertension, smoking, obesity, hyperlipidemia, and a type of heart disease, type 2 diabetes mellitus (Benjamin et al., 2019). In addition, school children with CFR affect learning achievement (Ekholuenetale et al., 2020; Yulianti et al., 2017).

Several studies have reported that increased CRF through exercise contributes to great health in patients with CVD and heart failure, with patients experiencing a reduced risk of hospitalization (Pandey et al., 2017). Another study showed that school children with obese nutritional status showed a cardiovascular response, namely an increase in pulse rate and systolic blood pressure (hypertension) (Delgado-Floody et al., 2020), adolescents with low levels of cardiorespiratory fitness showed the highest levels of systolic blood pressure and pressure products (Agostinis-Sobrinho et al., 2018). Correspondingly, research reports that poor CRF is independently associated with increased arterial stiffness and impaired arterial dilation capacity in children (Veijalainen et al., 2016). In addition, studies that are significantly related to physical or cardiovascular fitness in school children are nutritional status of obesity (Delgado-Floody et al., 2020), obesity, more nutrition (Gayatri et al., 2021), body mass index (Chen et al., 2022; Sunarni et al., 2019), sex (Priadana &; Suwandi, 2023), nutritional status and exercise habits (Cahyono et al., 2021), physical activity (Busono et al., 2023), haemoglobin or anaemia status (Pratiwi et al., 2021; Sudrajat et al., 2022), menstrual patterns (Arsi et al., 2023). Research on children in Europe by (Zaqout et al., 2016) reported several factors, namely age, sex, BMI of children, and physical activity, are independent and strong determinants of child fitness. However, research that studies the relationship between nutritional status and stunting indicators in children against CRF is rarely conducted, so it can contribute to intervention planning strategies to improve children's health from an early age and prevent adverse effects that can occur in adulthood.

CRF measurement has been recognised for its health and prognosis benefits but is rarely used for risk classification, such as in stunted children. Stunting is a global problem, especially in developing countries, including Indonesia. Stunting in Indonesia in 2021 has yet to reach the target set by WHO below 20% because stunting in Indonesia is 24.4% (Adityaningrum et al., 2023; Organization, 2018). However, the report on the Indonesian Nutritional Status survey results decreased from the previous year; 2018 amounted to 30.8%; 2019, 27.7%; and 2020, 26.9% (Adityaningrum et al., 2023). Meanwhile, Indonesia aims to reduce child growth and development disorders below 14% by 2024 (Siswati et al., 2022).

One elementary school in Lampung Province, Indonesia, has a stunting problem among its students, so it is important to assess the level of CRF. Stunting cases in Lampung Province are 42.6%, with the condition of Pesawaran Regency reaching 50.81%. Public health problems are considered high prevalence when the prevalence is short for 30% – 39% and very high when ≥ 40%. Thus, Lampung Province is included in the category of areas with a very high prevalence (Kemenkes, 2018). However, studies of the impact of stunting from an early age on children related to cardiorespiratory fitness are still rarely carried out. This study aims to examine the relationship of stunting to cardiorespiratory fitness in children. The results of this study can be used for strategic planning development efforts to prevent the impact of poor cardiorespiratory fitness on children in adulthood in the future.

Methods

The cross-sectional study demonstrates this research conducted at SD Negeri 13 Teluk Pandan Pesawaran in January 2020. The population in this study is grade IV, V, and VI children, namely 77 people at SD Negeri 13 Teluk Pandan with inclusion criteria for children aged 9-11 years who attend SD Negeri 13 Teluk Pandan, are grade IV, V, and VI students at SD Negeri 13 Teluk Pandan for the 2019/2020 school year, children who are categorised as stunting and stunting, have breakfast or lunch, willing to be a research respondent. Meanwhile, the exclusion criteria include children suffering from muscle and bone disorders, heart disease, asthma, and pulmonary TB. Using consecutive sampling techniques according to inclusion and exclusion criteria, 77 children.

The variable measurement of cardiorespiratory fitness level research uses a modified Harvard step test by Santoso (2020) with a tool used by a Harvard bench as high as 47 cm for men and 40 cm for women, a stopwatch, and a metronome of 120 x / minute beat rhythm. Harvard step test of modification according Santoso (2020) with the following procedures: 1) The examiner adjusts the metronome device based on the ups and downs of the bench, which is done with a rhythm of 120 x / minute; 2) calculate the participant's pulse for 0.5 minutes sitting position after the first step (as a warm-up or experiment; 3) Harvard step test with start instructions, then the participant places one dominant leg on the bench exactly the first second of the metronome and the stopwatch is pressed together as the first second; 4) Instruct participants to go up and down stairs with their right and left feet along with the rhythm of the second, third, and so on; 5) Harvard step test is stopped for 5 minutes or as expected, if fatigue before 5 minutes is given stop instructions and the stopwatch is stopped, then reset the stopwatch. 6) Record the duration of going up and down the bench; 7) instruct the body position during the test while going up and down the bench. It must be upright/straight, and the body position must be consistent, not bent over. If the body position is wrong for 10-15 seconds, despite repeated warnings, then the test is stopped, and the length of up and down the bench is recorded; 8) Immediately, the participant is instructed to sit down, take a pulse measurement to start calculating the pulse frequency recovery period after the Harvard step test. Use the stopwatch to calculate the pulse frequency for 30 seconds; 9) Calculate physical fitness/body fitness index or cardiorespiratory (IKB). IKB = (length of time up and down the bench in seconds x 100) divided by 5.5 x pulse frequency for 30 seconds; 10) Enter the IKB category score. The IKB test measurement results are categorised as bad / less once if the score is < 50, less if the score is 50-64, enough if the score is 65-80, good if the score is 81-90, very good if the score is > 90 (Yusuf, 2018).

Measurement bias was minimised by including criteria Participants when data collection was confirmed to be healthy and not achieved because participants did strenuous activities the day before. Measurements are made after stating they are willing to do cardiorespiratory fitness tests verbally and in writing. Meanwhile, stunting variables are measured using BB and TB anthropometric examinations with the PB / TB measurement index of children categorised as stunting if the measurement results are at the threshold of -3SD to < -2SD and not stunting if the index measurement according to PB / TB children is at the threshold of ≥ -2SD (Kemenkes, 2020).

The collected data were analysed using univariate analysis to describe the frequency distribution of respondents with stunting and non-stunting and the level of cardiorespiratory fitness with a Likert scale using tables. Bivariate analysis used the Spearman test to prove the association of stunting with cardiorespiratory fitness with a meaning level (α) of 0.05. This research was carried out after passing an ethical review by the Ethics Commission of Malahayati University Bandar Lampung, Indonesia. The implementation of research considers and applies research ethics during the research, starting with informed consent and giving respondents the right not to participate by maintaining the confidentiality of research data.

Results

The study's results involved 77 research subjects aged 9-11 elementary school children based on the incidence of stunting, cardiorespiratory fitness in stunted children, and normal. Table 1 shows that the incidence of stunting is 50.6% and not stunting is 49.4%. Stunted children who experience a poor level of cardiorespiratory fitness 92.3%, there is no good and sufficient level. Meanwhile, non-stunted children with cardiorespiratory fitness levels of less than 23.7%, other than adequate and good (76.3%) (Table 2).

Table 1.
Distribution of Respondents' Frequency Based on the Incidence of Stunting

Stunting	Frequency (n=77)	Percentage (n=100%)
Stunted	39	50,6
Normal	38	49,4

Table 2.
Distribution of Participation Frequency According to Cardiorespiratory Fitness in Stunted and Non-Stunted Children

Cardiorespiratory Fitness in stunted children	Frekuensi (n=39)	Percentage (n=100%)
Excellent	0	0
Good	0	0
Enough	0	0
Less	3	7,7
Bad/ lacking	36	92,3
Cardiorespiratory fitness in children not stunted		
Excellent	0	0
Good	4	10,5
Enough	25	65,8
Less	9	23,7
Bad/ lacking	0	0

Table 3.
The Relationship of Stunting with Cardiorespiratory Fitness in Children

Variable	R	P-value
Stunting and Cardiorespiratory Fitness	0,917	0,001

The results of statistical tests in Table 3 show that there is a significant relationship between stunting and cardiorespiratory fitness in children (p-value 0.001), and the influence of the strength level of the relationship between stunting variables and cardiorespiratory fitness is very strong (r-value of 0.917). A positive r-value analysis shows that the relationship between stunting and cardiorespiratory fitness is unidirectional, meaning that the closer the stunting standard deviation number, the lower the child's fitness level.

Discussion

This study aimed to assess the association of stunted primary school children with cardiorespiratory fitness levels. Research findings show a strong statistically positive relationship between stunting and cardiorespiratory fitness in children (r = 0.925). This means that stunted children with cardiorespiratory fitness are unidirectional; the closer the standard deviation of stunting is, the lower the fitness level of elementary school children is. The fitness level of stunted primary school children almost (92.3%) experienced poor cardiorespiratory fitness; compared to children who were not stunted, the level of cardiorespiratory fitness was good and sufficient, reaching 75% (see Table 2).

The participants of this study were elementary school children aged 9-12 years, both stunted and non-stunted children with varying levels of cardiorespiratory fitness. These findings are supported by previous research on the relationship between cardiorespiratory fitness and nutritional status. Nutritional status with BMI indicators is related to physical or cardiorespiratory fitness in school children (Arsi et al., 2023; Chen et al., 2022; Zaqout et al., 2016). In addition, anaemia factors or haemoglobin status (Pratiwi et al., 2021; Sudrajat et al., 2022), factors of menstrual patterns (Arsi et al., 2023), more nutrition and obesity (Delgado-Floody et al., 2020; Gayatri et al., 2021) reported a link with physical fitness in school children.

Cardiorespiratory fitness (CRF) is one of the most important health components of physical fitness (Mijalković et al., 2022) in children. It has a close relationship with the overall level of health in youth (Ruiz et al., 2016). The poor level of cardiorespiratory fitness in stunted children, as the findings of this study, may be caused by various factors related to other nutritional status indicators. As reported by research by (Gontarev et al., 2018) in Macedonia, in children aged 6-14 years, normal weight, stunting, and excess weight obtained different or significant fitness test results. Stunted children can experience a decrease in cardiorespiratory fitness if they have haemoglobin deficiency (anaemia) (Gayatri et al., 2021; Sudrajat et al., 2022) or abnormal menstrual patterns that cause anaemia (Arsi et al., 2023). The condition of anaemia in the body decreases the ability of haemoglobin to bind oxygen gas and metabolism for the mechanical activity of the heart and lungs. The effects of anaemia cause the supply of oxygen to the tissues for carbohydrate metabolism, resulting in reduced energy. When doing activities, stunting children's heart power has the potential to decrease, which causes fatigue quickly (Hall & Hall, 2020). This situation allows for reducing the level of physical fitness or CFR of stunted children. CRF indicates the body's integrated function ability to transport oxygen from the atmosphere to mitochondria, which is useful for cellular respiration and adeno triphosphate (ATP) or energy-producing metabolism. Energy is necessary for physical activity. Thus, it reflects the overall capacity of the cardiovascular and respiratory systems and the ability to perform Long-term physical exercise (Ross et al., 2016; Hall & Hall, 2020). Several research results show that children's daily physical activity affects cardiorespiratory fitness (Busono et al., 2023; Delgado-Floody et al., 2020).

Stunted children experience a decline in physical fitness specifically associated with malnutrition and malnutrition during growing children. This condition can cause structural, metabolic, and functional changes in skeletal muscle, manifesting as decreased muscle fibers. Muscle fibers affect physical performance and change (Armstrong et al., 2017). As a result, stunted children experience poor physical fitness, which reflects the capacity of heart and lung function (Ross et al., 2016). Stunting in children associated with malnutrition can cause suboptimal brain development, negatively impacting cognitive development, including learning achievement and economic productivity in adulthood (Ekholuenetale et al., 2020). The adverse impact of CRF has been widely evidenced to be associated with a high risk of cardiovascular disease, all-cause mortality, and various types of cancer (Harber et al., 2017).

The magnitude of the adverse impact of CRF on stunted children and efforts to improve cardiorespiratory fitness have been very important since childhood, especially in children with stunting. Exercise or physical exercise that is appropriate and not excessive should be a program in children, in addition to adequate micronutrient intake to improve cardiorespiratory fitness. The hope is that children live healthy lives and avoid non-communicable diseases that occur progressively in old age. Further research is needed for a larger sample involving other nutritional status indicators, such as anaemia status, nutritional intake, children's physical activity, and even social demographic factors, to be able to provide findings with high external validity.

Conclusion

This study found that the growth status of stunted children influences cardiorespiratory fitness. Almost all children with stunting have poor cardiorespiratory fitness. These findings point to the need for government attention in every country to pay attention to adverse impacts on children's cognitive development and health in the future. We recommend that governments and stakeholders ensure that children with stunting receive adequate health and nutrition services, including micronutrients, such as iodine, vitamin A, and iron, as well as cognitive development-stimulating interventions. The results of this study contribute to the consideration of developing intervention planning strategies to improve cardiorespiratory fitness in elementary school children, especially children with stunting status.

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