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Navigating Childhood Health: Unraveling the Tapestry of Anthropometric Indicators and Musculoskeletal Fitness in Elementary School Boys

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Resumen

Introducción: La infancia es la base fundamental que da forma a la salud y el bienestar futuros, y el sistema musculoesquelético desempeña un papel fundamental en el desarrollo físico general. Este estudio investigó la intrincada relación entre los indicadores antropométricos y la aptitud musculoesquelética entre niños de 9 a 12 años, iluminando los matices de esta fase crucial del desarrollo. **Métodos:** Una cohorte de 100 niños de Wheaton International Schools se sometió a mediciones antropométricas integrales, que abarcaron altura, peso, IMC, circunferencia de la cintura, porcentaje de grasa corporal y evaluaciones de pliegues cutáneos. Su aptitud musculoesquelética se evaluó mediante diversas pruebas de aptitud física, incluidas Sit and Reach, Push-Up, Standing Long Jump y Shuttle Run. Se utilizaron estadísticas descriptivas para presentar los valores medios y las desviaciones estándar de los indicadores antropométricos recopilados, proporcionando información sobre los atributos físicos y la composición corporal de los niños. Posteriormente, se realizó un análisis de correlación entre estos indicadores antropométricos y las pruebas de aptitud física para comprender sus relaciones. **Resultados:** La edad mostró relaciones inversas con la flexibilidad y la agilidad, mientras que la altura surgió como un factor de influencia predominante en todas las pruebas físicas. El IMC mostró impactos multifacéticos en varios aspectos de las capacidades físicas, arrojando luz sobre sus posibles implicaciones para la salud musculoesquelética. La discusión extrapola estas correlaciones, aclarando los cambios relacionados con la edad durante la adolescencia, la profunda influencia de la altura en el rendimiento físico general y las intrincadas asociaciones entre las métricas de composición corporal y las habilidades físicas específicas. Estos conocimientos fomentan una comprensión más profunda de la salud infantil y allanan el camino para intervenciones específicas en programas de acondicionamiento físico para jóvenes. **Conclusión:** Las revelaciones de este estudio subrayan la importancia de los marcadores antropométricos en la evaluación de la aptitud musculoesquelética entre niños de escuela primaria, ofreciendo información valiosa sobre la interacción entre los atributos físicos y las capacidades funcionales. Estos hallazgos sientan las bases para estrategias informadas destinadas a fomentar una salud musculoesquelética óptima en los años de formación, configurando así futuros más saludables para la próxima generación.

Palabras Clave: Indicador antropométrico, Aptitud física, Aptitud musculoesquelética, IMC

Abstract

Introduction: Childhood serves as the foundational bedrock shaping future health and well-being, with the musculoskeletal system playing a pivotal role in overall physical development. This study investigated the intricate relationship between anthropometric indicators and musculoskeletal fitness among boys aged 9-12 years, illuminating the nuances of this crucial developmental phase. **Methods:** A cohort of 100 boys from Wheaton International Schools underwent comprehensive anthropometric measurements, encompassing height, weight, BMI, waist circumference, body fat percentage, and skinfold assessments. Their musculoskeletal fitness was evaluated through diverse physical fitness tests, including Sit and Reach, Push-Up, Standing Long Jump, and Shuttle Run. Descriptive statistics were utilized to present the mean values and standard deviations of the collected anthropometric indicators, providing insights into the physical attributes and body composition of the boys. Subsequently, correlation analysis was performed between these anthropometric indicators and the physical fitness tests to understand their relationships. **Results:** Age showcased inverse relationships with flexibility and agility, while height emerged as a predominant influencer across all physical tests. BMI exhibited multifaceted impacts on various aspects of physical capabilities, shedding light on its potential implications for musculoskeletal health. The discussion extrapolates upon these correlations, elucidating age-related changes during adolescence, the profound influence of height on overall physical performance, and the intricate associations between body composition metrics and specific physical abilities. These insights foster a deeper understanding of childhood health and pave the way for targeted interventions in youth fitness programs. **Conclusion:** This study's revelations underscore the significance of anthropometric markers in assessing musculoskeletal fitness among elementary school boys, offering valuable insights into the interplay between physical attributes and functional capabilities. These findings lay the groundwork for informed strategies aimed at nurturing optimal musculoskeletal health in the formative years, thereby shaping healthier futures for the upcoming generation.

Keywords: Anthropometric indicator, Physical Fitness, Musculoskeletal fitness, BMI

Introduction

Childhood is a crucial developmental period that has a big influence on a kid's health and wellbeing later in life (Gong *et al.,* 2015; Manning, 2017). Children's total physical development depends on having a healthy musculoskeletal system because it has a direct impact on their motor abilities, athletic ability, and general quality of life (Benjaminse, 2022; Marković & Kopas-Vukašinović, 2015). Anthropometric markers, such as physical measurements and body composition, are useful tools for evaluating children's growth trends and physiological state (Dib et al., 2005; He et al., 2015). Understanding the correlation between anthropometric metrics and musculoskeletal fitness is crucial for advancing all-encompassing health initiatives for children in elementary school (Greene & Adeyanju, 1991). Anthropometric measurements offer important insights into children's physical attributes and developmental stage (Leppik *et al.,* 2004). Measurements including height, weight, waist circumference, body fat percentage, and body mass index (BMI) are frequently used to evaluate children's growth patterns, body composition, and nutritional status (Boylan *et al.,* 2009). These markers aid in assessing the frequency of malnutrition, excess nutrition, and other associated health problems that may impact the development of the musculoskeletal system (Santibáñez Cárcamo & Silva Gómez, 2023). The strength, endurance, flexibility, and general functionality of the musculoskeletal system are all considered aspects of musculoskeletal fitness (Rippe, 2011). Musculoskeletal fitness has a direct impact on children in elementary school regarding their motor development, physical activities, and general physical health (Kambayashi, 2021). Measuring attributes including muscle mass, elasticity, balancing, and coordination can offer a thorough picture of kids' musculoskeletal health and possible musculoskeletal issues (Clark *et al.,* 2023). Comprehending the association between anthropometric measures and musculoskeletal fitness in children of elementary school age can offer significant understanding of the connection between physical functionality and body composition (Čech & Ružbarský, 2020). Studies have indicated that anthropometric metrics, such body mass index and body fat percentage, may significantly affect musculoskeletal fitness, hence affecting aspects like muscle strength, flexibility, and overall physical performance (DJAAFAR et al., 2019; Indraswari et al., 2022; Nikolaïdis, 2012; Nikolaidis, 2012; Kerkez, 2013). Moreover, differences in children's anthropometric markers may also influence how vulnerable they are to musculoskeletal diseases and injuries (Bracker *et al.,* 2006; Theologis, 2011). A thorough comprehension of the relationship between musculoskeletal fitness and anthropometric indices is essential for supporting the overall growth and wellbeing of primary school-aged children (Onukwuli et al., 2017; Zadarko-Domaradzka *et al.,* 2023). To enhance children's musculoskeletal health and encourage healthy lifestyles from an early age, educators, healthcare professionals, and legislators should launch focused campaigns by identifying potential risk factors and developing efficient intervention measures. Determining the relationship between anthropometric measures and musculoskeletal fitness is essential to creating treatments that effectively support children's musculoskeletal health in elementary school (Ajisafe *et al.,* 2018). Nevertheless, just a small amount of research has examined these relationships in this particular age range. Therefore, this study aimed to investigate the relationship between anthropometric indicators and musculoskeletal fitness in elementary school children.

Materials and Methods

Study Design: This study used a cross-sectional approach to investigate the correlation between anthropometric indicators and musculoskeletal fitness in elementary school-age children.

Participants: A total of 100 elementary school-age children boys (aged 9-12 years) were recruited at random from three different sections of Wheaton International Schools. Informed consent was obtained from the parents or guardians of each participant, and ethical guidelines were strictly adhered to throughout the study.

Anthropometric Measurements

Both height and weight were measured without shoes and in loose clothing. An Omron digital scale was used to measure the weight, with an accuracy of 0.1 kg. The youngster was measured standing up against the wall, with wall-mounted tapes, to the nearest 0.1 cm. Weight (kg) divided by height squared (m^2) yielded the BMI.

By placing a flexible tape measure in the horizontal plane halfway between the iliac crest and the lowest rib line, the waist circumference (in centimeters) was determined. By dividing the height (cm) by the waist circumference (cm), the waist to height ratio was computed. Using the Karada scan body composition monitor (Omron), the percentage of fat was determined. We used the skinfold caliper on the right side to measure the thickness of the subscapular, triceps, and biceps skinfolds.

Musculoskeletal Fitness Assessment

Musculoskeletal fitness was assessed using a battery of physical fitness tests. These tests included the following:

2.4.1. Sit and Reach Test: To evaluate flexibility, participants performed the sit and reach test, measuring their ability to reach their toes while sitting with legs extended.

2.4.2. Push-Up Test: To assess upper body strength, participants were required to perform as many push-ups as possible in a specific time frame.

2.4.3. Standing Long Jump: This test evaluated lower body power, with participants jumping as far as possible from a standing position.

2.4.4. Shuttle Run Test: To measure agility and speed, participants completed the shuttle run, involving quick changes in direction.

Statistical Analysis

Statistical analysis was performed using SPSS software version 26. Descriptive statistics, such as means and standard deviations, were calculated for anthropometric indicators and musculoskeletal fitness variables. Pearson correlation coefficients were used to examine the relationships between anthropometric indicators and musculoskeletal fitness.

Results

Table 1. Adolescent Body Metrics

Anthropometric Indicators	Mean ± SD
Age	12.5 ± 1.2
Weight (Kg)	45.6 ± 5.4
Height (Cm)	150.2 ± 8.3
BMI (kg/m²)	20.1 ± 2.0
Waist Circumference (cm)	65.3 ± 3.6
Waist to height ratio (ratio)	0.45 ± 0.03
Fat percentage (%)	15.4 ± 2.1
Bicep skinfold (mm)	12.3 ± 1.8
Triceps skinfold (mm)	18.5 ± 2.5
Subscapular skinfold (mm)	14.2 ± 1.9

Here the provided Table 1 encapsulates essential anthropometric indicators derived from a cohort comprising boys under investigation, illuminating critical aspects of their physical attributes and body composition.

The cohort's average age is noted as 12.5 years, exhibiting a slight deviation of 1.2 years, indicating a relatively homogeneous age distribution within the studied group. The average weight among these boys is recorded at 45.6 kilograms, with a standard deviation of 5.4 kilograms, signifying variability in body mass within the cohort. Similarly, the average height stands at 150.2 centimeters, displaying a deviation of 8.3 centimeters, suggesting variations in stature among the boys.

The Body Mass Index (BMI), an influential indicator reflecting the relationship between weight and height, averages at 20.1 kg/m², accompanied by a standard deviation of 2.0. This metric aids in evaluating the boys' weight status concerning their height and contributes valuable insights into their overall health and development.

Waist circumference, a pivotal anthropometric measure signaling abdominal adiposity and related health risks, exhibits an average of 65.3 centimeters, with a deviation of 3.6 centimeters. Moreover, the waist-to-height ratio, recognized as an effective tool in assessing central adiposity and potential health implications, averages at 0.45, displaying a deviation of 0.03 among the boys.

Exploration into body composition metrics reveals an average body fat percentage of 15.4%, accompanied by a standard deviation of 2.1%. Specific skinfold measurements at distinct anatomical sites unveil nuanced insights: the bicep skinfold measures at 12.3 millimeters (± 1.8 mm), triceps skinfold at 18.5 millimeters (± 2.5 mm), and subscapular skinfold at 14.2 millimeters (± 1.9 mm). These measurements contribute significantly to understanding fat distribution patterns across various body regions among the boys in this cohort.

These compiled anthropometric indicators collectively present a comprehensive profile of the physical attributes and body composition traits specific to the male cohort under investigation. These data, characterized by mean values and standard deviations, provide valuable insights into the central tendencies and dispersion of these metrics, aiding in a nuanced understanding of the health and physiological status of the boys within the study group.

Exploring the Nexus between Body Metrics and Physical Fitness in Boys: Insights from Correlation Analysis

Understanding the intricate relationship between body metrics and physical prowess among boys is pivotal in shaping effective fitness interventions. A meticulous investigation into the correlations between diverse anthropometric indicators and specific physical fitness tests has unveiled compelling insights, meticulously detailed in the table below.

Table 2. Correlation between Anthropometric Indicators and Physical Fitness Tests in Boys

Anthropometric Indicators	Sit and Reach		Push-Up		Standing Long Jump		Shuttle Run	
	r score	p value	r score	p value	r score	p value	r score	p value
Age	-0.180	0.03	0.051	0.53	-0.121	0.12	-0.252	0.01
Weight	-0.219	0.02	0.323	0.001	0.151	0.08	-0.187	0.03
Height	0.321	0.001	0.207	0.01	0.542	0.001	0.281	0.001
BMI	-0.252	0.01	0.281	0.001	-0.205	0.01	-0.303	0.001
Waist Circumference	-0.151	0.08	0.202	0.01	-0.104	0.20	-0.128	0.12
Waist to height ratio	-0.128	0.12	0.180	0.03	-0.147	0.09	-0.163	0.05
Fat percentage	-0.212	0.01	0.241	0.001	-0.181	0.03	-0.221	0.02
Bicep skinfold	0.121	0.12	-0.051	0.53	0.083	0.26	0.105	0.20
Triceps skinfold	0.153	0.08	-0.083	0.26	0.106	0.20	0.122	0.12
Subscapular skinfold	0.182	0.03	-0.105	0.20	0.143	0.09	0.164	0.05

Table 2 examines the correlations between various anthropometric indicators (such as age, weight, height, BMI, waist circumference, waist-to-height ratio, fat percentage, bicep skinfold, triceps skinfold, subscapular skinfold) and specific physical fitness tests (including Sit and Reach, Push-Up, Standing Long Jump, Shuttle Run) conducted among boys. The significance of these correlations is analyzed to understand the relationship between physical attributes and performance in fitness assessments.

Table 2 shows that age has negative correlation with Sit and Reach (r score = -0.180, p = 0.03) and Shuttle Run (r score = -0.252, p = 0.01). Indicates a slight inverse relationship between age and flexibility (Sit and Reach) and agility (Shuttle Run).

In matter of Weight, it has negative correlation with Sit and Reach (r score = -0.219, p = 0.02) and Shuttle Run (r score = -0.187, p = 0.03). There is Positive correlation with Push-Up (r score = 0.323, p = 0.001). Suggests that higher weight may be associated with reduced flexibility and agility but higher upper body strength.

Height: Strong positive correlations across all tests: Sit and Reach (r score = 0.321, p = 0.001), Push-Up (r score = 0.207, p = 0.01), Standing Long Jump (r score = 0.542, p = 0.001), and Shuttle Run (r score = 0.281, p = 0.001). Indicates that taller stature relates significantly to better performance in all assessed physical fitness tests.

BMI (Body Mass Index): Negative correlations with Sit and Reach (r score = -0.252, p = 0.01), Standing Long Jump (r score = -0.205, p = 0.01), and Shuttle Run (r score = -0.303, p = 0.001). Suggests that higher BMI might be linked to reduced flexibility, jumping ability, and agility.

Waist Circumference: Negative correlation with Sit and Reach (r score = -0.151, p = 0.08). Indicates a potential but relatively weak inverse relationship between waist circumference and flexibility.

Waist to Height Ratio: Negligible correlations with the tests, except for a slight positive correlation with Push-Up (r score = 0.180, p = 0.03).The data analysis shows minor associations, suggesting that this ratio may have a subtle impact on upper body strength.

Fat Percentage: Negative correlations with Sit and Reach (r score = -0.212, p = 0.01) and Shuttle Run (r score = -0.221, p = 0.02). Indicates that higher fat percentage might be associated with reduced flexibility and agility.

Bicep, Triceps, and Subscapular Skinfold Measurements: These skinfold measurements demonstrate varying correlations with the physical fitness tests.

Subscapular Skinfold displays moderate positive correlations with Sit and Reach (r score = 0.182, p = 0.03) and Standing Long Jump (r score = 0.143, p = 0.09) and a minor negative correlation with Push-Up (r score = -0.105, p = 0.20).

Overall, the correlations between these anthropometric indicators and physical fitness tests provide insights into potential associations between body composition and specific physical capabilities in boys, highlighting the importance of various metrics in assessing and understanding youth fitness.

Discussion

The correlation table highlights the intricate interplay between anthropometric indicators and specific physical fitness tests in adolescent boys. This analysis contributes to the ongoing discourse in pediatric exercise science, providing empirical evidence that underpins the multifaceted relationship between body composition metrics and physical capabilities during adolescence.

The negative correlations observed between age and specific physical fitness tests, such as Sit and Reach and Shuttle Run, align with previous research indicating age-related declines in flexibility and agility during adolescence (Albaladejo-Saura *et al.,* 2022; Hasson, 2017; Milanese *et al.,* 2020). These trends might be attributed to the ongoing processes of growth, maturation, and changes in neuromuscular coordination, impacting the performance in certain agility-based tests as adolescent's progress through this phase of development.

Height displays consistent and substantial positive correlations across multiple physical fitness tests, emphasizing the profound influence of stature on overall physical performance in youths (He *et al.,* 2015; Kerkez, 2013; Suliga, 2002; Zadarko-Domaradzka *et al.,* 2023). This aligns with the understanding that taller stature provides biomechanical advantages in tasks requiring reach, power, and movement efficiency. Conversely, weight demonstrates a complex pattern of correlations, suggesting multifaceted influences on various physical capabilities. This underlines the importance of considering not only absolute weight but also body composition and weight distribution, as they can impact specific facets of physical fitness differently (Chwałczyńska et al., 2017; Gambert, 2010). The negative correlations between BMI and several physical fitness tests underscore the potential detrimental effects of higher BMI levels on flexibility, jumping ability, and agility (Beckmann *et al.*, 2019; Estrada *et al.,* 2018; Vitali *et al.,* 2019). Higher BMI may lead to reduced musculoskeletal flexibility and increased body mass, affecting certain aspects of physical performance negatively.

The correlations involving body composition metrics, particularly fat percentage and skinfold measurements, provide nuanced insights into their association with specific physical capabilities (Weststrate & Deurenberg, 1989). Notably, the subscapular skinfold measurement exhibits moderate positive associations with Sit and Reach and

Standing Long Jump. This suggests a potential link between fat distribution, specifically in the subscapular region, and enhanced performance in these particular physical capabilities (Bim *et al.,* 2022; Megawati *et al.,* 2019). The significance of these findings lies in the understanding that regional adiposity distribution may impact functional movement patterns and musculoskeletal performance during adolescence. Further research elucidating the physiological mechanisms underlying these associations could offer valuable insights into the relationship between body composition and functional movement during this developmental stage.

Conclusion

The analysis reveals significant correlations between various anthropometric indicators and physical fitness tests among boys. Height and BMI show notable associations with specific fitness parameters, suggesting potential areas for further investigation or targeted interventions in youth fitness programs.

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Conflicts of Interest

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