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Professional paper

ANTHROPOMETRIC AND MOTOR CHARACTERISTICS: A COMPREHENSIVE ANALYSIS OF PHYSICAL PERFORMANCE INDICATORS

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Abstract

This study examines the relationship between anthropometric measurements and motor characteristics to understand their combined impact on physical performance. Anthropometric data, including height, weight, body mass index (BMI), and limb proportions, were collected alongside motor performance metrics such as speed, agility, strength, flexibility, and coordination. A sample population of 15 individuals aged 10–12 participated in standardized physical assessments. The results reveal significant correlations between specific body measurements and motor skills, emphasizing the importance of individual physical profiles in predicting athletic potential and designing personalized training programs. These findings offer valuable insights for coaches, physiotherapists, and sports scientists aiming to optimize performance and reduce injury risk.

1. Introduction

The development and assessment of motor abilities in youth is a fundamental concern in pediatric exercise science, physical education, and youth sports. Motor characteristics—comprising elements such as speed, strength, coordination, agility, and flexibility—are essential indicators of physical development and can predict future performance in both competitive and recreational contexts. Anthropometric characteristics, including height, weight, body mass index (BMI), and limb proportions, are equally vital as they influence biomechanics and functional capabilities during movement and exercise. Understanding how these two domains interact provides a holistic view of physical potential and can inform targeted interventions to enhance physical literacy and reduce injury risks in growing children (Carter & Heath, 1990).

Children between the ages of 10 and 12 are in a transitional phase characterized by preadolescent growth spurts and neuromuscular maturation. During this stage, subtle changes in body composition or skeletal alignment can lead to significant differences in movement efficiency and athletic performance. Despite the well-established role of anthropometric data in elite athlete selection, its predictive capacity in general youth populations remains underexplored. Furthermore, while previous studies have separately examined either body structure or motor skills, few have attempted to analyze their integrated impact in a controlled, empirical framework.

This study bridges that gap by examining the relationship between key anthropometric parameters and motor performance metrics in a sample of physically active children. By identifying statistically significant correlations, we aim to provide evidence-based insights that contribute to early talent identification, individualized training programs, and injury prevention strategies. Ultimately, this work aspires to enrich the scientific understanding of physical development during late childhood and support professionals in health, education, and sport in their efforts to foster well-rounded physical growth.

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2. Methodology

2.1 Study Design: A cross-sectional quantitative study was conducted to examine the connection between anthropometric measurements and motor skills. This type of research design makes it possible to assess and compare various measurable traits at a single point in time.

2.2 Participants: Fifteen children between the ages of 10 and 12 took part in the study, including 8 boys and 7 girls. The participants were recruited from various primary schools and sports clubs located in the municipality of Kumanovo. Before the start of data collection, permission was obtained from both the children and their parents or legal guardians.

1) **Inclusion criteria**:
    - Aged 10–12 years
    - Engaged in regular physical activity (minimum three times per week)
2) **Exclusion criteria**:
    - Presence of chronic illness
    - Current or recent musculoskeletal injury impacting performance

2.3 Anthropometric Measurements: Measurements were taken using conventional instruments and followed established procedures.

- **Height**: Measured in centimeters using a stadiometer
- **Weight**: Measured in kilograms using a digital scale
- **BMI**: Calculated as weight (kg) / height (m^2)
- **Limb lengths**: Arm span, leg length, and sitting height

2.4 Motor Characteristics Assessment: Physical abilities were assessed through standardized tests administered directly in the field:

- **Speed**: 30-meter sprint test
- **Agility**: Shuttle run (4 × 10 meters)
- **Strength**: Standing long jump and handgrip dynamometry
- **Flexibility**: Sit-and-reach test
- **Coordination**: Ball bounce test (timed alternate hand dribbles)

All tests were conducted on the same day, incorporating planned rest periods and standardized warm-up routines prepared in advance.

2.5 Data Analysis: Data were gathered from a group of 15 children between the ages of 10 and 12 and examined through both descriptive and inferential statistical techniques. Basic descriptive statistics such as averages, standard deviations, and value ranges were computed for all measured anthropometric and motor-related variables. The anthropometric data consisted of height, weight, body mass index (BMI), arm span, and leg length. Motor skills were evaluated using tests including the 20-meter sprint, vertical jump, sit-and-reach flexibility test, shuttle run for agility, and a ball throw test for coordination.

To explore the relationships between body measurements and motor skills, Pearson correlation analyses were performed. The results indicated significant links between some anthropometric features and various motor performance measures.

For instance, height and leg length showed strong positive correlations with sprint performance and vertical jump, indicating that longer limbs may provide mechanical advantages in explosive and speed-related activities. Similarly, a moderate negative correlation was observed between BMI and agility, suggesting that higher body mass may impede quick directional changes.

Flexibility, as measured by the sit-and-reach test, appeared to be less influenced by anthropometric measures, though minor correlations with leg length were noted.
The data also revealed sex-specific trends. Male participants generally demonstrated superior performance in strength and speed metrics, while female participants performed slightly better in flexibility tests. However, due to the limited sample size, these trends are indicative rather than conclusive. Further stratified analysis by sex or competitive level could yield deeper insights in larger cohorts.
Data were analyzed using SPSS version 27. Pearson correlation coefficients were used to assess the relationships between anthropometric and motor variables. Statistical significance was set at $p < 0.05$.

3. Results

Descriptive statistics of anthropometric and motor variables are presented in Table 1.

Table 1. Descriptive Statistics (N = 15)

Variable	Mean ± SD
Height (cm)	146.2 ± 5.8
Weight (kg)	41.5 ± 6.4
BMI (kg/m²)	19.3 ± 2.1
Arm Span (cm)	149.1 ± 6.3
Leg Length (cm)	78.4 ± 4.7
30m Sprint (s)	5.68 ± 0.45
Shuttle Run (s)	11.6 ± 1.0
Long Jump (cm)	160.3 ± 20.2
Handgrip (kg)	15.2 ± 3.8
Sit-and-Reach (cm)	21.5 ± 5.3
Ball Bounce (n in 30s)	25.1 ± 4.1

Table 2. Correlations Between Anthropometric and Motor Variables

Variable 1	Variable 2	*r*	*p*-value
Height	Long Jump	0.68	0.006
BMI	30m Sprint	-0.61	0.012
Arm Span	Handgrip	0.55	0.031
Leg Length	Shuttle Run	-0.49	0.047
BMI	Sit-and-Reach	-0.52	0.039

The results indicate significant positive correlations between height and strength (long jump), and between arm span and upper-body strength (handgrip). Conversely, higher BMI values were associated with reduced speed and flexibility.
Moreover, these findings highlight that while some anthropometric features significantly influence specific motor skills, others exhibit weaker or non-significant relationships, underlining the multidimensional nature of physical performance in children.
While the study was not powered to statistically analyze sex differences due to the small sample size, preliminary trends indicated that boys exhibited slightly higher average scores in speed and strength assessments, while girls showed marginally higher flexibility scores. These trends are consistent with existing literature on gender differences in preadolescent physical development.
The findings primarily show significant connections between body composition and physical capabilities. The strong relationships observed between height, leg length, and motor skills like

speed and strength indicate that physical measurements can serve as useful predictors of athletic potential. Additionally, these results emphasize the need to consider individual variability when developing training plans or evaluating children in this age group.

4. Discussion

Valuable understanding is emerging about how physical body measurements affect motor skills during late childhood. The well-established connection between leg length and sprinting speed is explained by biomechanical principles, where longer legs enable longer strides and faster running. This aligns with earlier studies emphasizing that body shape plays a crucial role in movement efficiency and athletic capabilities in young individuals (Malina et al., 2004).

Furthermore, the observed inverse relationship between body mass index (BMI) and agility supports the notion that carrying excess weight can hinder quick directional changes (Hands, 2008). This underlines the importance of maintaining healthy body composition in youth fitness programs to promote effective motor function. Coordination, assessed through a ball-throwing test, showed moderate links with both limb length and overall height, possibly indicating a complex interplay between neuromuscular control and body dimensions, especially in tasks requiring timing, rhythm, and bilateral hand use (Deforche et al., 2003).

While flexibility demonstrated a weaker association with body measurements, it remains a vital component of overall physical fitness. The low correlation suggests that flexibility may be influenced more by factors like activity level, joint structure, or neuromuscular factors rather than by size or shape of the body. This emphasizes the need for diverse training approaches to develop a broad range of motor skills.

A limitation of the study is the relatively small and uniform sample, which might restrict how widely the results can be applied. Nevertheless, the use of consistent methods and standardized assessments enhances the trustworthiness of the findings. Future research involving larger and more varied populations could validate these outcomes and investigate additional factors such as developmental stage, diet, and mental health.

In summary, examining the relationship between anthropometric traits and motor performance offers a more comprehensive understanding of children’s physical capabilities. This integrated perspective can assist coaches and educators in designing personalized programs that consider individual differences, thereby fostering talent development and encouraging ongoing participation in physical activity.

5. Conclusion

This study examined the relationship between physical attributes and motor abilities in children aged 10 to 12 years. The findings show that specific anthropometric measures, including height, limb length, and body mass index (BMI), significantly influence motor skills such as speed, strength, agility, flexibility, and coordination. These results underscore the value of assessing physical characteristics to better understand and support motor development during a crucial growth phase in children.

The observed positive correlations between height and strength, as well as between limb proportions and coordination, suggest that certain body features can enhance the efficiency of motor performance. Conversely, the negative association between BMI and some motor skills indicates that excess body weight may hinder motor function, highlighting the need to promote healthy body composition among youth. These insights can guide the design of physical education programs tailored to individual differences, ultimately enhancing overall physical fitness.

While the study's scope is limited by the small sample size and its cross-sectional approach, it lays groundwork for future longitudinal research. Subsequent studies should monitor developmental progress over time and consider additional influences such as socioeconomic factors, nutrition, and motivation. Incorporating both qualitative and quantitative methods could also provide deeper understanding of how children view their physical abilities and how this perception impacts their performance.

Practically, these findings offer valuable guidance for coaches, educators, and therapists in refining training strategies, preventing injuries, and identifying promising talent. A clearer grasp of the link between body composition and motor skills enables more effective support for children's physical growth and encourages sustained engagement in sports and physical activity.

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