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THE RELATIONSHIP BETWEEN BODY COMPOSITION AND MOTOR ABILITIES IN YOUNG FOOTBALL PLAYERS (U10 CATEGORY)

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ABSTRACT

This study investigated the relationship between body composition (body fat and skeletal muscle percentage) and fundamental motor abilities motor abilities (speed, explosive power, agility) in 18 male youth football players (U10) from FC Vitez from Serbia. Body composition was assessed via bioelectrical impedance, while motor performance was evaluated using a 20m sprint (5m/10m splits), a jump test battery (squat jump, countermovement jump, countermovement jump with arm swing, standing long jump) and agility tests (T-test, Illinois, slalom). Body fat percentage demonstrated a strong negative correlation with all explosive power tests, peaking with the Squat Jump ($r = -0.80$, $p < 0.01$). It correlated positively with 10m ($r = 0.64$, $p < 0.01$) and 20m ($r = 0.67$, $p < 0.01$) sprint times and all agility scores, meaning higher fat associated to poorer performance. Skeletal muscle percentage showed a strong positive correlation with explosive power (Squat jump $r = 0.86$, $p < 0.01$) and a strong negative correlation with sprint and agility results ($p<0.05$) (higher muscle mass associated to faster times). No one parameter significantly correlated with the short 5m sprint ($p>0.05$). Body composition is closely related to athletic capacity in U10 football players. Excess adiposity acts as a passive inertial load that hinders acceleration and maneuvering, whereas developed muscle mass is shows a strong positive relationship with explosive force.

Key words: correlation, locomotion, anthropometry, preadolescents

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INTRODUCTION

Football can be defined as a highly dynamic sports game in which low-intensity activities continuously alternate with short-term, high-intensity movements such as fast accelerations, maximum sprints, and sudden changes of direction, all in line with the current situation on the pitch (Sarmento et al., 2020; Slimani et al., 2019). The modern game demands the execution of between 150 and 250 short anaerobic actions, fast accelerations, and sprints (Mohr et al., 2003), as well as around 700 changes of direction during a single match (Bloomfield et al., 2007). For this very reason, the ability to accelerate, change direction quickly, and reach maximum speed represents critical components in situations that decide the outcome of a match (Bradley et al., 2010). Aside from speed and agility, explosive power plays a vital role in the motor ability spectrum of football players. Explosive power, particularly of the lower body, is a critical component for performing movements such as vertical and horizontal jumps, kicking the ball and the first steps during acceleration (Turner & Stewart, 2014).

In addition to these motor abilities, a football player’s success and efficiency are mostly influenced by their body composition, which stands as one of the most important indicators of an athlete’s health, physical fitness and nutritional status (American College of Sports Medicine, 2021). Body composition reveals the qualitative structure of total body mass and directly describes the athlete’s movement efficiency on the pitch. In scientific practice, it is most frequently observed through a two-component model that distinguishes between fat mass (adipose tissue) and fat-free mass, which includes muscles, bones, and total body water (Ackland et al., 2012; Kahraman & Arslan, 2023). The sports performance itself is highly influenced by the mutual relationship between fat mass and fat-free (muscle) mass (Heyward & Wagner, 2004). From a biomechanical perspective, an increased body fat percentage acts as a passive load that increases total body inertia, directly prolonging reaction time and reducing sprint speed (Nikolaidis et al., 2015). On the other hand, a well-developed fat-free mass increases the muscle cross-sectional area, which recruits a higher number of motor units and results in more explosive and faster movements (Leão et al., 2022). Therefore, it is essential for football players to possess an adequate body composition that meets all the demands of the sport and allows them to achieve optimal performance on the pitch.

Previous research on this topic is extensive, indicating that the subject is highly relevant and widely discussed. A number of studies have confirmed a correlation between body composition and motor abilities in older age groups (Atakan et al., 2017; França et al., 2024; Esco et al., 2018; Koltai et al., 2021; Leão et al., 2022). However, significantly less attention has been paid to younger categories, specifically football players under the age of 10. A few investigations focusing on this younger age group confirm that an elevated body fat percentage is negatively correlated with speed, agility and explosive power (Aristotelis et al., 2015; Pérez-López et al., 2015; Prieto Valle., 2020; Hermassi et al., 2022), while being positively correlated with sprint time and agility performance in some contexts (Daga et al., 2023). Conversely, fat-free mass shows a positive correlation with explosiveness (Pérez-López et al., 2015) and speed (Peñailillo et al., 2016) but negative with agility with or without ball (Koltai et al., 2021; Esco et al., 2018) In contrast to these findings, there are studies that found no significant relationship between body composition and motor abilities in young football players (Hermassi et al., 2024; Infantes et al., 2025). Such divergent findings clearly point to the need for further and more detailed investigation of this problem in youth football players.

The rationale for this study lies in the fact that the period around 10 years of age is crucial for the development of basic motor abilities, as well as for the shaping of body composition under the influence of an organized training program. While this relationship has been clearly examined and established in older age categories, scientific findings on this specific age group remain scarce and contradictory. More detailed and high-quality approach to this topic is needed to precisely determine the degree of correlation between these parameters and how they contribute to proper athletic development during this critical age. Therefore, the aim of this study was to determine the relationship between body composition parameters (body fat percentage and skeletal muscle percentage) and speed, lower-limb explosive power, and agility in young soccer players under 10 years.

METHOD

Participants:

Eighteen active male football players, competing for FC Vitez (mean ± SD: age 9.7 ± 0.8 years, body height 141.0 ± 5.8 cm, body mass 36.7 ± 7.7 kg, and BMI 18.3 ± 3.2 kg/m^2), participated in the study. The inclusion criteria for participation required subjects to: 1) be involved in a regular training program for at least one year; 2) regularly attend training sessions (3 times per week); 3) be free from any acute or chronic injuries or illnesses at the time of testing. Given that the participants were minors, written informed consent was obtained from the parents of all participants after they were thoroughly informed about the testing procedures. In addition to parental consent, the management of FC Vitez and the team coach also gave their consent for conducting the research. Participants had the right to withdraw from the research at any time if they wanted to. The study protocol was approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Niš, in accordance with the Declaration of Helsinki (04-965/3).

Procedures:

All assessments were conducted on a single day during the afternoon hours, after the participants had a rest day. The measurement protocol began on an outdoor artificial grass football pitch, where the subjects’ training sessions are usually held. Before the start, all participants went through a standard 10-minute warm-up led by their coach, which consisted of a five-minute run with specific tasks and short accelerations lasting a total of 5 minutes.

Before performing each test, the correct execution of the task for each test was demonstrated to the participants, after which they had one practice attempt to get better acquainted with the execution procedure. The order and dynamics of the measurement itself were organized in accordance with the logistical possibilities on the field, aiming to prevent participant fatigue. First, the speed assessment tests were performed by all participants, after which the participants were divided into three groups: one performed explosive power tests, one performed agility tests, and one had their body composition and body height measured. After that, the groups rotated so that each group completed all measurements. For all lower limb explosive power tests, participants had three attempts, except for the long jump, where they had 2 attempts, as was the case for the speed and agility tests. An adequate rest period was provided between each attempt and the best attempt was used for further data analysis. During the realization of the motor ability tests, participants wore sports equipment and football shoes, while during the measurement of body height and body composition assessment, they had to be barefoot.

Variables:

Anthropometric measures

Body height was measured in accordance with the instructions of the International Biological Program (IBP) (Weiner & Lourie, 1969). An anthropometer (GPM, Siber and Hegner, Zurich, Switzerland) with an accuracy of 0.1 cm was used for the measurement. Body mass with an accuracy of 0.1 kg and BMI were measured using a scale (BF511, Omron Healthcare Co., Ltd., Kyoto, Japan).

Body composition

Regarding body composition parameters, body fat percentage and skeletal muscle percentage were measured. A scale (BF511, Omron Healthcare Co., Ltd., Kyoto, Japan) with an accuracy of 0.1% was used for the measurement. To ensure high reliability of the results, the researcher's instructions regarding the correct body position during measurement were strictly followed. The participants stood in an upright position, barefoot, with extended knees, evenly distributed weight, and their gaze directed straight ahead. The heels and hands had to be well positioned on the electrodes, with the arms fully extended and positioned horizontally at a 90-degree angle to the torso. They wore only t-shirts and shorts. Furthermore, they had no physical activity for the preeceding 12 hours and no meals for the 2 hours prior to the measurement.

Explosive power

To evaluate lower-limb explosive power, a battery of four tests was utilized. There were three vertical jumps and one horizontal. Vertical jump heights were estimated indirectly through flight time-the interval between take-off and landing- using an optical measurement system (Optojump, Microgate, Bolzano, Italy) to the nearest 0.1 cm. Participants performed three trials per test with a one-minute rest interval between attempts and the highest jump was selected for analysis. Upon landing, participants were required to maintain their position for a minimum of two seconds; any loss of balance invalidated the trial, prompting a re-test after a one-minute rest (Espada et al., 2023).

Countermovement jump (CMJ). Participants initiated the test from an upright position with hands firmly placed on the hips. They were instructed by the researchers to perform a rapid downward countermovement to a knee angle of approximately 90 degrees, immediately followed by a maximal vertical jump (Espada et al., 2023).

Countermovement jump with arm swing (CMJwas): Similar to the CMJ, this test is a valid and reliable instrument for evaluating explosive power (Slinde et al., 2008). The kinematic structure is identical to the CMJ, with the exception that the arms are free to move. During the eccentric phase, participants swung their arms backward, forcefully driving them forward and upward during the concentric phase to maximize the force impulse and jump height (Atabaş et al., 2020).

Squat jump (SJ): This test assesses the concentric component of lower-limb power by eliminating the stretch-shortening cycle. The SJ was executed following previously validated protocols (Atabaş et al., 2020; Espada et al., 2023). Participants assumed a static half-squat position with hands on hips and knees flexed at 90 degrees. From this static position, without any preliminary downward movement, they performed a maximal vertical jump.

Standing long jump (SLJ): The SLJ was administered according to the procedures described by Atabaş et al. (2020). Participants stood behind a designated starting line on a firm, non-slip surface, with feet shoulder-width apart. Utilizing a simultaneous arm swing and knee flexion, they performed a maximal bilateral forward jump. Jump distance was measured to the nearest 1 cm using a tape measure, from the starting line to the rearmost heel upon landing. Two trials were executed, and the best score was retained for analysis.

Speed

Speed measurement was performed using a 20m sprint test, registering split times at 5m and 10m according to the protocol used by García-Pinillos et al. (2015). A system of electronic photocells (Witty, Microgate, Bolzano, Italy) was used for time measurement. Four pairs of photocell gates were placed on the starting line and at distances of 5m, 10m, and 20m from the start. All photocells were placed at hip height so that the subjects would not break the laser beam with arm movements, which would start the timing early and cause the time to reset and the test to be repeated. The distance between two tripods of the same photocell pair was 120 cm. The participants assumed the starting position at a distance of 50 cm from the start, preventing premature signal activation. When ready, the participants would start running at maximum speed, while the system automatically registered the time. Each participant performed two attempts with a two-minute passive rest between attempts. The better obtained result, expressed in seconds with an accuracy of 1/100s, was taken for statistical data processing. Constant encouragement of all participants by the researchers was provided during the test execution.

Agility

To measure change-of-direction speed with and without a ball, a test battery comprising the T-test, Illinois test, and slalom tests (with and without a ball) was implemented. Completion times were recorded using the aforementioned electronic photocell system (Witty, Microgate, Bolzano, Italy). The researchers provided continuous verbal encouragement to elicit maximal effort. The T-test and Illinois test were conducted in accordance with procedures described by Mijalković et al. (2023).

T-test: This test assesses directional changes encompassing forward sprinting, left and right shuffling, and backpedaling. Participants began in an upright stance with both feet behind the starting line (A), marked by a photocell gate. Upon the researchers' signal, they sprinted forward 9.14 m to touch the center cone (B) with their right hand. They then shuffled laterally to the left, without crossing their feet, for 4.57 m to touch the left cone (C) with their left hand. Subsequently, they shuffled 9.14 m to the right to touch the far-right cone (D) with their right hand, shuffled 4.57 m back to the center cone (B) touching it with their left hand, and finally backpedaled as rapidly as possible across the starting line (A). Trials were disqualified and repeated if participants crossed their legs or failed to touch the base of the cones. Each participant completed two trials, and the fastest time was recorded (França et al., 2024; Sassi et al., 2009). The reliability and validity of this test have been well established (Pauole et al., 2000).

Illinois test. Four cones designated the corners, while four central cones were placed in a straight line, separated by 3.33 m intervals. Participants started from an upright position behind the photocell gate at the bottom-left corner. Following the researchers' signal, they sprinted 10 m straight to the top-left cone, navigated around it, and sprinted diagonally to the first central cone. They then run through the central cones, sprinted diagonally to the top-right cone, rounded it, and finished with a 10-m straight sprint through the photocell gate at the bottom-right corner. The reliability and validity of the Illinois test have been confirmed for male team sports (Hachana et al., 2013).

Slalom test (without and with a ball): These soccer-specific agility tests were adopted from Milanović et al. (2013). The polygon dimensions and cone placements were identical for both variations: six cones were arranged in a straight line at 2-m distance, with the first cone positioned 1 m from the start line. Slalom test without a ball: Participants started behind the line in an upright stance. Following the researchers' signal, they run through the cones, mandatorily entering from the right side of the first cone. After rounding the final cone, participants executed a 180-degree turn and navigated back through the cones along the same path, finishing through the photocell gate. The validity and reliability of this protocol have been previously verified (Sporiš et al., 2010).

Slalom test with a ball: This test was executed in the exact same manner, with the addition of dribbling a ball throughout the designated path

Statistical analysis

Statistical data analysis was performed in the Jamovi software package (Version 2.3, The jamovi project, Sydney, Australia). Descriptive statistical analysis was done for all tested variables (anthropometric measures, body composition components, and motor ability test results). Before applying more complex statistical procedures, the normality of data distribution was checked using the Shapiro-Wilk test. Correlation analysis was applied to determine the relationship between body composition parameters and motor ability test results. According to the normality test results, Pearson's correlation was used for variables that follow a normal distribution, while Spearman's correlation was applied for variables that deviate from a normal distribution. The level of statistical significance for all applied analyses was set at p < 0.05.

RESULTS

Table 1. Descriptive statistics and correlation matrix between body composition and motor abilities (N=18)

Variables	Mean ± SD	Body Fat (%)	p	Skeletal Muscle (%)	p
Body Fat (%)	19.80 ± 7.88	/	/	-0.71**	0.001
Skeletal Muscle (%)	34.40 ± 2.69	-0.71**	0.001	/	/
Sprint 5m ⁺	1.24 ± 0.06	0.22	0.390	-0.29	0.245
Sprint 10m	2.15 ± 0.12	0.64**	0.004	-0.49*	0.037
Sprint 20m	3.86 ± 0.24	0.67**	0.002	-0.62**	0.006
CMJ	20.70 ± 5.35	-0.77***	<0.001	0.74***	<0.001
CMJwas	24.10 ± 5.49	-0.77***	<0.001	0.71***	<0.001
SJ	19.80 ± 5.38	-0.80***	<0.001	0.86***	<0.001
SLJ	144.00 ± 25.90	-0.64**	0.004	0.72***	<0.001
T-test ⁺	13.60 ± 1.57	0.56*	0.018	-0.82***	<0.001
Illinois Test	18.80 ± 1.27	0.56*	0.018	-0.63**	0.005
Slalom Test	9.71 ± 0.89	0.48*	0.043	-0.61**	0.007
Slalom with Ball	15.60 ± 2.76	0.54*	0.020	-0.50*	0.033

*Legend: Mean ± SD – Mean and Standard Deviation; ⁺ – Spearman's rho correlation coefficient applied due to non-normal distribution; Pearson's r correlation coefficient is displayed for all other variables; * p < .05,** p < .01, *** p < .001.*

The results indicate that body fat percentage has a statistically significant negative correlation with the results in all explosive power tests. The strongest negative correlation was achieved with SJ (r = -0.80, p < 0.01), followed by CMJ (r = -0.77,

$p < 0.01$), CMJwas ($r = -0.77$, $p < 0.01$), and SLJ ($r = -0.642$, $p < 0.01$). In addition, the findings indicate a statistically significant positive correlation between body fat percentage and split times on the 10m ($r = 0.64$, $p < 0.01$) and 20m ($r = 0.67$, $p < 0.01$) sprint tests, while in the 5m sprint test, no statistically significant relationship with body fat percentage was achieved (rho = -0.216, $p > 0.05$). Regarding the agility tests, body fat percentage achieved a statistically significant positive correlation with the results obtained at the T-test (rho = 0.56, $p < 0.05$), Illinois test ($r = 0.56$, $p < 0.05$), slalom test ($r = 0.48$, $p < 0.05$), and slalom test with a ball ($r = 0.54$, $p < 0.05$.

In contrast, the results regarding the relationship between skeletal muscle percentage and the results on the explosive power, speed, and agility tests show a completely different correlation trend compared to body fat percentage. Skeletal muscle percentage showed a statistically significant positive correlation with the results on all explosive power tests, with the strongest relationship recorded for the SJ test ($r = 0.86$, $p < 0.01$), followed by CMJ ($r = 0.74$, $p < 0.001$), then SLJ ($r = 0.72$, $p < 0.01$), and finally the CMJwas test ($r = 0.71$, $p < 0.01$). In addition, skeletal muscle percentage achieved a statistically significant negative correlation with the results on almost all speed and agility tests, except for the 5m sprint test, where no statistically significant correlation was achieved (rho = -0.29, $p > 0.05$). The strongest negative relationship was found for the T-test ($r = -0.82$, $p < 0.01$), followed by the Illinois test ($r = -0.63$, $p < 0.01$), 20m sprint ($r = -0.62$, $p < 0.01$), slalom test ($r = -0.61$, $p < 0.01$), slalom test with a ball ($r = -0.50$, $p < 0.05$), and 10m sprint ($r = -0.49$, $p < 0.05$).

DISCUSSION

The primary objective of this study was to determine the relationship between body composition parameters—specifically body fat percentage and skeletal muscle percentage—and motor abilities including speed, explosive power, and agility in young soccer players under 10 years. The main findings demonstrate that body fat percentage is significantly negatively correlated with lower-limb explosive power, while showing a significant positive correlation with sprint results (at 10m and 20m) and results of the agility tests, indicating that elevated fat levels are linked to lower athletic performance. Conversely, skeletal muscle percentage exhibited a strong positive relationship with all explosive power tests and a strong negative relationship with sprint and agility times, reflecting its role as a powerful facilitator of superior motor output.

Relationship between body fat and motor abilities

Regarding lower-limb explosive power, body fat percentage demonstrated its strongest negative correlation with the Squat Jump ($r = -0.80$, $p < 0.01$), Countermovement jump ($r = -0.77$, $p < 0.01$), Countermovement jump with arm swing ($r = -0.77$, $p < 0.001$), and standing long jump ($r = -0.64$, $p < 0.01$). These results fully support previous research on youth and pre-pubertal football players, confirming that excess fatness diminishes jumping capacity (Aristotelis et al., 2014; Hermassi et al., 2022; Pérez-López et al., 2015; Prieto Valle, 2020). From a biomechanical perspective, excess adipose tissue acts as a non-functional, passive load that increases total body inertia. When executing a vertical or horizontal jump, the athlete must overcome this total inertia against gravity; therefore, unnecessary fat weight directly impairs relative force production and jump height, a mechanism previously detailed in a study by Nikolaidis et al. (2015).

A particularly interesting trend emerged during the linear speed assessment. While body fat percentage showed a significant positive correlation with results obtained for the 10m ($r = 0.64$, $p < 0.01$) and 20m ($r = 0.67$, $p < 0.01$), it did not achieve statistically significant correlation with the initial 5m sprint split (rho= 0.21, $p>0.05$). These findings corroborate the conclusions of Esco et al. (2018) and França et al. (2024), who noted that field-based sprinting performance over extended distances is intimately tied to overall body composition and fat accumulation. This lack of relationship over the first 5 meters suggests that the initial steps of a sprint are primarily governed by reaction time, technical stance, and rapid neuromuscular firing rates rather than the gross qualitative structure of total body mass (Yildiz et al., 2018). However, as the player transitions into the main acceleration phase (10m to 20m), the detrimental drag of excess fat mass becomes heavily pronounced.

The results of this study also demonstrated a consistent and statistically significant positive correlation between body fat percentage and the results of all applied agility tests. Specifically, higher adiposity was associated with slower results in the T-test (rho = 0.56, $p < 0.05$), the Illinois test ($r = 0.56$, $p < 0.05$), the slalom test without a ball ($r = 0.48$, $p < 0.05$), and the slalom test with a ball ($r = 0.54$, $p < 0.05$). According to Nikolaidis et al. (2015), an elevated body fat percentage significantly increases the total inertia of the body. Our data corroborate the findings of Aristotelis et al. (2015), Prieto Valle (2020), and Hermassi et al. (2022), who collectively demonstrated that higher fat mass accumulation acts as a primary limiting factor for agility performance in young soccer players. Additionally, the positive correlation with completion times mirrors the trends reported by Daga et al. (2023), confirming that pre-pubertal players with unoptimized body composition face distinct physical disadvantages during agility-based drills. In practice, this means that a young player's fat mas exert substantially greater muscular force to counteract momentum, slow down, and shift their center of gravity during sharp turns. Because this adipose tissue does not contribute to force generation, it directly prolongs the time required to complete multidirectional movements, thereby reducing overall movement efficiency on the pitch.

Despite the robust correlations observed in this cohort, these fat-mass findings contrast with certain recent investigations that found no significant relationship between body composition and physical fitness parameters in young soccer players (Hermassi et al., 2024; Infantes et al., 2025). These divergent findings in the literature can likely be explained by differences in the biological maturation and structured training age of the observed samples.

Relationship between skeletal muscle and motor abilities

On the other hand, skeletal muscle percentage achieved a completely different correlation trend compared to body fat percentage, acting as a critical facilitator across all physical domains. In terms of lower-limb explosive power, skeletal muscle percentage achieved its strongest positive correlation with the Squat Jump test ($r = 0.86$, $p < 0.01$), followed by Countermovement jump ($r = 0.74$, $p < 0.01$), then standing long jump ($r = 0.72$, $p < 0.01$), and finally the Countermovement jump with arm swing ($r = 0.71$, $p < 0.01$). This aligns with the physiological consensus that a larger muscle cross-sectional area enables the recruitment of a greater number of motor units, resulting in faster and more explosive concentric contractions (Leão et al., 2022). This relationship highlights that developed muscle tissue is the primary active driver capable of generating the high forces required for explosive vertical and horizontal movements, fully supporting the concept that fat-free mass fosters overall explosiveness in youth athletes (Pérez-López et al., 2015).

During the linear speed assessment, a higher skeletal muscle percentage was significantly associated with shortened (faster) times at the 10m ($r = -0.49$, $p < 0.05$) and 20m ($r = -0.62$, $p < 0.01$) marks. These findings confirm conclusions of Peñailillo et al. (2016) establishing that maximizing active, fat-free mass is essential for achieving superior field-based sprinting performance over extended distances. Similar to the fat mass trend, skeletal muscle percentage did not exhibit a statistically significant correlation with the initial 5m split ($rho = -0.29$, $p > 0.05$). This further confirms that while ultra-short distances are governed by rapid neuromuscular firing and starting mechanics, the propulsive benefit of skeletal muscle mass becomes heavily pronounced once the athlete transitions into the main acceleration phase (10m to 20m).

Our findings also indicate that a higher skeletal muscle percentage is strongly and negatively linked to completion times across multidirectional agility tasks. Muscle percentage achieved highly significant negative relationships with the T-test ($r = -0.82$, $p < 0.01$), Illinois test ($r = -0.63$, $p < 0.01$), and the slalom test without a ball ($r = -0.61$, $p < 0.01$). The overall strong link between skeletal muscle and agility in this cohort supports previous documentation by Koltai et al. (2021) and Esco et al. (2018) regarding the interaction between body composition and maneuverability. Biomechanically, these multi-directional tasks require rapid eccentric braking to decelerate the body, followed immediately by explosive concentric re-acceleration in a new direction. Developed skeletal muscle provides the essential structural and functional capacity to absorb and generate these extreme forces efficiently. Interestingly, when dribbling a ball was introduced to the slalom test, the correlation with skeletal muscle slightly weakened ($r =-0.50$, $p < 0.05$), though it remained statistically significant. This minor reduction suggests that while physical capacity remains fundamental, specific technical soccer skills and ball control introduce additional variance into the final performance outcome.

CONCLUSION

Based on the findings, a clear relationship between body composition and motor abilities has been established. Excess body fat is associated with increased body inertia and lower efficiency in multidirectional movements and rapid accelerations more challenging. Conversely, skeletal muscle percentage shows strong positive correlations with enhanced explosive power, speed, and agility. A particularly interesting exception is the lack of correlation between body composition and the 5-meter sprint, which suggests that performance over short (5m) distances is likely governed by other factors, such as reaction time and starting mechanics (Yildiz et al., 2018). The practical application of this study highlights the importance of focusing on optimizing body composition at this age, rather than strictly prioritizing technical and tactical skill development. In other words, placing greater emphasis on a healthy physical profile supports improvements in key motor abilities, which correspond to better movement profiles on the football pitch.

Limitations of study

The primary limitation of this study is the relatively small sample size (N = 18) players from a single football club (FC Vitez), which significantly restricts the generalizability of the findings to a broader population of youth athletes. From a methodological standpoint, a small sample size reduces the statistical power of the analysis and increases susceptibility to sampling fluctuations. Consequently, correlation coefficients calculated from small cohorts can exhibit sample-to-sample instability or potential overestimation of effect sizes, meaning the observed relationships between body composition parameters and motor abilities should be interpreted with caution. While these preliminary findings offer valuable insights into pre-pubertal U10 players, future research must incorporate larger, multicenter sample sizes to verify the stability and robustness of these correlations across diverse athletic populations. Furthermore, body composition was estimated using bioelectrical impedance analysis via a field scale rather than laboratory gold-standard methods such as dual-energy X-ray absorptiometry (DEXA) or InBody. Because the device relies on generalized algorithms, it is limited in providing a true assessment for children under 10 years of age, whose early biological maturation and tissue water ratios can lead to an over-or underestimation of fat mass. Future research should have longitudinal designs to track how the interactions between body composition and motor abilities evolve as players transition through puberty. Aditionally, next studies should incorporate partial correlations or regression analyses in order to control for potential confounding variables and obtain even more precise insights into the relationship among the examined variables.

REFERENCES

1. Ackland, T. R., Lohman, T. G., Sundgot-Borgen, J., Maughan, R. J., Meyer, N. L., Stewart, A. D., & Müller, W. (2012). Current status of body composition assessment in sport: Review and position statement on behalf of the ad hoc research working group on body composition health and performance, under the auspices of the IOC Medical Commission. *Sports Medicine*, *42*(3), 227–249. https://doi.org/10.1007/BF03262275
2. American College of Sports Medicine. (2021). *ACSM's guidelines for exercise testing and prescription* (11th ed.). Lippincott Williams & Wilkins.
3. Aristotelis, G., Evangelos, B., Stergios, K., Ioannis, G., & Foteini, A. (2014). Does body fat affect performance indicators in youth soccer? *British Journal of Education, Society & Behavioural Science*, *5*(1), 90–97. https://doi.org/10.9734/BJESBS/2015/12711
4. Atabaş, E. G., Öksüzoğlu, A. Y., Türel, S., & Akça, S. (2020). The relationship of polymorphism with explosive forces in ACTN3, ACE, and UCP3 genes in soccer players. *Progress in Nutrition*, *22*(3), 1–10. https://doi.org/10.23751/pn.v22i3.9785
5. Atakan, M. M., Unver, E., Demırcı, N., Cinemre, Ş. A., Bulut, S., & Turnagol, H. H. (2017). Effect of body composition on fitness performance in young male football players. *Turkish Journal of Sport and Exercise*, *19*(1), 54–59. https://doi.org/10.15314/tsed.311400
6. Bloomfield, J., Polman, R., & O'Donoghue, P. (2007). Physical demands of different positions in FA Premier League soccer. *Journal of Sports Science & Medicine*, *6*(1), 63–70.
7. Daga, F. A., Agostino, S., & Cazzoli, S. (2023). The impact of age and body composition on physical fitness and soccer skills among pre-pubertal players in "mixed-age" teams. *Annals of "Dunarea de Jos" University of Galati. Fascicle XV, Physical Education and Sport Management*, *2*, 38–48. https://doi.org/10.35219/efsm.2023.2.05
8. Esco, M. R., Fedewa, M. V., Cicone, Z. S., Sinelnikov, O. A., Sekulic, D., & Holmes, C. J. (2018). Field-based performance tests are related to body fat percentage and fat-free mass, but not body mass index, in youth soccer players. *Sports*, *6*(4), Article 105. https://doi.org/10.3390/sports6040105
9. Espada, M. C., Jardim, M., Assunção, R., Estaca, A., Ferreira, C. C., Pessôa Filho, D. M., Ribeiro, J., & Santos, F. J. (2023). Lower limb unilateral and bilateral strength asymmetry in high-level male senior and professional football players. *Healthcare*, *11*(11), Article 1579. https://doi.org/10.3390/healthcare11111579
10. França, C., Gouveia, É. R., Martins, F., Ihle, A., Henriques, R., Marques, A., Sarmento, H., Field, A., & Lopes, H. (2024). Lower-body power, body composition, speed, and agility performance among youth soccer players. *Sports*, *12*(5), Article 135. https://doi.org/10.3390/sports12050135
11. García-Pinillos, F., Ruiz-Ariza, A., Moreno del Castillo, R., & Latorre-Román, P. Á. (2015). Impact of limited hamstring flexibility on vertical jump, kicking speed, sprint, and agility in young football players. *Journal of Sports Sciences*, *33*(12), 1293–1297. https://doi.org/10.1080/02640414.2015.1022573
12. Hachana, Y., Chaabène, H., Nabli, M. A., Attia, A., Moualhi, J., Farhat, N., & Elloumi, M. (2013). Test-retest reliability, criterion-related validity, and minimal detectable change of the Illinois agility test in male team sport athletes. *The Journal of Strength & Conditioning Research*, *27*(10), 2752–2759. https://doi.org/10.1519/JSC.0b013e31828906c0

13. Hermassi, S., Bartels, T., Hayes, L. D., & Schwesig, R. (2022). Fitness, fatness, and academic attainment in male schoolchildren from a soccer academy. *International Journal of Environmental Research and Public Health*, *19*(5), Article 3106. https://doi.org/10.3390/ijerph19053106
14. Hermassi, S., Konukman, F., Al-Marri, S. S., Hayes, L. D., Bartels, T., & Schwesig, R. (2024). Associations between biological maturation, physical performance, postural control, and mathematical achievement in youth soccer players. *PLoS ONE*, *19*(3), Article e0298301. https://doi.org/10.1371/journal.pone.0298301
15. Heyward, V. H., & Wagner, D. R. (2004). *Applied body composition assessment* (2nd ed.). Human Kinetics.
16. Infantes, S. C., Silva, A. F., Hermoso, V. M. S., Jabalera, J. O., Clemente, F. M., & Fernández, F. T. G. (2025). Assessing the impact of body composition and physical fitness parameters on performance prediction in youth soccer players. *Retos: Nuevas Tendencije u Educación Física, Deporte y Recreación*, *73*, 300–313.
17. Kahraman, M. Z., & Arslan, E. (2023). The relationship between body composition and biomotor performance parameters in U18 football players. *Physical Education of Students*, *27*(1), 45–52. https://doi.org/10.15561/20754671.2023.0106
18. Koltai, M., Gusztafik, Á., Nagyváradi, K., Szeiler, B., Halasi, S., & Lepeš, J. (2021). The connection between the agility of adolescent soccer players and their body composition. *Facta Universitatis, Series: Physical Education and Sport*, *19*(3), 577–588. https://doi.org/10.22190/FUPES211025055K
19. Leão, C., Silva, A. F., Badicu, G., Clemente, F. M., Carvutto, R., Greco, G., Cataldi, S., & Fischetti, F. (2022). Body composition interactions with physical fitness: A cross-sectional study in youth soccer players. *International Journal of Environmental Research and Public Health*, *19*(6), Article 3598. https://doi.org/10.3390/ijerph19063598
20. Mijalković, S., Mladenović, K., & Ilić, T. (2023). Body composition and motor abilities of young football players. *Journal of Anthropology of Sport and Physical Education*, *7*(2), 19–22. https://doi.org/10.26773/jaspe.230404
21. Milanović, Z., Sporiš, G., Trajković, N., James, N., & Šamija, K. (2013). Effects of a 12 week SAQ training programme on agility with and without the ball among young soccer players. *Journal of Sports Science & Medicine*, *12*(1), 97–103.
22. Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences*, *21*(7), 439–449. https://doi.org/10.1080/0264041031000101897
23. Pauole, K., Madole, K., Garhammer, J., Lacourse, M., & Rozenek, R. (2000). Reliability and validity of the T-test as a measure of agility, leg power, and leg speed in college-aged men and women. *The Journal of Strength & Conditioning Research*, *14*(4), 443–450. https://doi.org/10.1519/1533-4287(2000)014<0443:RAVOTT>2.0.CO;2
24. Peñailillo, L., Espíldora, F., Jannas-Vela, S., Mujika, I., & Zbinden-Foncea, H. (2016). Muscle Strength and Speed Performance in Youth Soccer Players. *Journal of Human Kinetics*, *50*(1), 203–210. https://doi.org/10.1515/hukin-2015-0157
25. Pérez-López, A., Sinovas, M. C., Álvarez-Valverde, I., & Valades, D. (2015). Relationship between body composition and vertical jump performance in young Spanish soccer players. *Journal of Sport and Human Performance*, *3*(3), 1–11. https://doi.org/10.12922/jshp.0055.2015
26. Prieto Valle, A. (2020). Influence of body composition in the physical fitness of 10- to 11-year-old football players. *Atena Journal of Sports Sciences*, *2*, Article 3.
27. Sarmento, H., Clemente, F. M., Araújo, D., Davids, K., McRobert, A., & Figueiredo, A. (2020). What performance analysts need to know about research trends in association football (2012–2016): A systematic review. *Sports Medicine*, *50*(4), 799–836. https://doi.org/10.1007/s40279-019-01186-6

28. Sassi, R. H., Dardouri, W., Yahmed, M. H., Gmada, N., Mahfoudhi, M. E., & Gharbi, Z. (2009). Relative and absolute reliability of a modified agility T-test and its relationship with vertical jump and straight sprint. *The Journal of Strength & Conditioning Research*, *23*(6), 1644–1651. https://doi.org/10.1519/JSC.0b013e3181b425d2

29. Slinde, F., Suber, C., Suber, L., Edwén, C. E., & Svantesson, U. (2008). Test-retest reliability of three different countermovement jumping tests. *The Journal of Strength & Conditioning Research*, *22*(2), 640–644. https://doi.org/10.1519/JSC.0b013e3181660475

30. Slimani, M., Znazen, H., Miarka, B., & Bragazzi, N. L. (2019). Maximum oxygen uptake of male soccer players according to their competitive level, playing position and age group: Implication from a network meta-analysis. *Journal of Human Kinetics*, *66*(1), 233–245. https://doi.org/10.2478/hukin-2018-0050

31. Sporis, G., Jukic, I., Milanovic, L., & Vucetic, V. (2010). Reliability and factorial validity of agility tests for soccer players. *The Journal of Strength & Conditioning Research*, *24*(3), 679–686. https://doi.org/10.1519/JSC.0b013e3181c4d321

32. Turner, A. N., & Stewart, P. F. (2014). Strength and conditioning for soccer players. *Strength & Conditioning Journal*, *36*(4), 1–13. https://doi.org/10.1519/SSC.0000000000000069

33. Weiner, J. P., & Lourie, J. A. (1969). *Human biology: A guide to field methods*. Blackwell Scientific Publications.

34. Yildiz, S., Ates, O., Gelen, E., Çirak, E., Bakici, D., Sert, V., & Kayihan, G. (2018). The Relationship between Start Speed, Acceleration and Speed Performances in Soccer. *Universal Journal of Educational Research*, *6*(8), 1697-1700.

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