THE RELATIONSHIP BETWEEN SEGMENTAL LEAN MASS AND SINGLE-LEG COUNTERMOVEMENT JUMP PERFORMANCE IN YOUNG BASKETBALL PLAYERS

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ABSTRACT
Vertical jumping ability, fundamentally dependent on lower-body explosive strength and power, constitutes a critical performance metric in basketball. The purpose of this study was to examine the relationship between segmental lean mass of the lower limbs and the single-leg countermovement jump. Twenty-five young basketball players (17 ± 0.9 years) with a minimum of five years of experience in basketball training were recruited for analysis. Bioelectrical Impedance Analysis (InBody 770) and Kistler (Quattro Jump) force platforms were used. Bivariate correlation showed a significant positive correlation for segmental lean mass of the dominant leg and maximal force during the concentric phase in the single-leg jump (r = .55, p = .05). Moreover, a positive correlation was found between vertical jump height and the other variables (r = .67, p = .01). Relative maximal force during the eccentric phase of the jump showed positive correlation as well (r = .59, p = .04). This research provides strong confirmation of the importance of targeted lower-limb muscle mass development in maximizing single-leg jump performance among young basketball athletes. These findings give strength and conditioning coaches clear, practical data they can use to structure training programs that directly focus on maximizing the specific power athletes need for their sport.

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INTRODUCTION

Basketball is a sport that requires a high level of physical fitness and technical skills, with particular emphasis on abilities such as speed, endurance, strength, and coordination (Shalfawi, Sabbah, Kailani, Tønnessen, & Enoksen, 2011). Among the key aspects of the game, the ability to generate propulsive force for vertical jumping stands out as an essential performance determinant, since it is used in numerous situations, from jumping for the ball, shooting, defending, and blocking (Rodríguez-Rosell, Mora-Custodio, Franco-Márquez, Yáñez-García, & González-Badillo, 2017). Furthermore, the rate at which an athlete can generate force (rate of force development) is critical, as jumps often occur following rapid decelerations (Pinheiro Brandão, de Andrade & do Carmo, 2024). This explosive capacity is directly linked to the utilization of the stretch-shortening cycle during the countermovement phase.

Successful jumping depends on several interrelated factors, including technique, explosive power, and the player's morphological characteristics. Previous research has shown that leg strength and balance are key determinants of athletic performance in basketball players (Gonzalo-Skok, Serna, Rhea, & Marín, 2015; Bazanov, Pedak, & Rannama, 2019). However, the distribution of lean mass between limbs may also play an important role in determining jumping performance. In young basketball players undergoing rapid growth, muscle imbalances can lead to movement inefficiency, reduced coordination, or an increased risk of injury (Čaušević et al., 2023).

The quality and distribution of lean mass are particularly important for explosive actions such as vertical jumps and sprints (Correas-Gómez, Benítez Flores, Gonzalez, & Carnero, 2023). Athletes with higher lean body mass (LBM) and better inter-limb symmetry tend to generate greater force output and achieve superior jumping and sprinting results (Hernandez-Martinez et al., 2024; Pamuk et al., 2023). Furthermore, dynamic balance and neuromuscular coordination can moderate the impact of morphological asymmetries on sport-specific performance, which is especially relevant during adolescence (Domínguez-Navarro et al., 2023; Lisón et al., 2022).

Considering the complexity of these factors, understanding the relationship between segmental lean mass and explosive performance may provide valuable insight into optimal strength development and injury prevention in youth athletes. Therefore, *this study aimed* to examine the relationship between the percentage of segmental leg lean mass and vertical jump performance in young basketball players. It was hypothesized that a higher proportion of lean mass in the dominant leg would be positively correlated with jump height and maximal concentric force during the single-leg countermovement jump (CMJ).

METHODOLOGY

Sample and Study Design

The sample of this study consisted of 25 junior male basketball players competing in the official junior leagues under the Basketball Federation of Serbia. The participants were 17 years old, healthy, and had a minimum of five years of systematic basketball training experience. All participants underwent a standard medical examination to exclude any musculoskeletal or systemic disorders that might influence performance outcomes. The research was designed as a correlational cross-sectional study, aiming to determine the relationship between segmental lean mass of the dominant leg and single-leg vertical jump performance. Testing sessions were performed in the university biomechanics laboratory under standardized environmental conditions (temperature 22 ± 1°C). All participants were instructed to avoid any intense training activity 48 hours prior to testing. All testing was completed in a single session, beginning with anthropometric and body composition assessment, followed by vertical jump performance on a force platform. Each participant underwent a familiarization session prior to data collection to ensure proper technique execution.

Body Composition Analysis (InBody Test)

Segmental body composition, including lean mass of the dominant leg, was assessed using a bioelectrical impedance analyzer (InBody 770, Biospace Co., Ltd., Seoul, South Korea). Participants stood barefoot on the device, maintaining full contact with the foot and hand electrodes for approximately 60 seconds. The following parameters were recorded: total body mass (kg), BMI (kg/m²), and segmental lean mass (kg) for the dominant leg.

Single-leg Countermovement Jump (CMJ) Test

Vertical jump performance was measured using a force platform (Kistler, Switzerland) connected to a computer-based data acquisition system. Participants performed single-leg countermovement jumps (CMJ) on both the dominant and non-dominant legs. The starting position required the participant to stand upright on one leg with hands on the hips. After a controlled countermovement to a self-selected depth, each participant executed a maximal vertical jump while keeping the non-jumping leg flexed and unassisted. The test was repeated three times, with 2-minute rest periods between attempts. The following parameters were extracted from the force-time curve: jump height (cm), calculated from flight time; relative maximal force ($N \cdot kg^{-1}$) during the eccentric (countermovement) phase; and relative maximal force ($N \cdot kg^{-1}$) during the concentric (push-off) phase. The highest result from the three successful trials was used for further analysis.

Statistical Analysis

Data were analyzed using SPSS software (version 26.0, IBM Corp., USA). Descriptive statistics (mean ± standard deviation) were calculated for all measured variables. The Shapiro–Wilk test was applied to verify data normality. Pearson's correlation coefficients (r) were computed to determine the relationships between segmental lean mass and performance variables. Correlation coefficients are generally interpreted as low or weak for values below 0.35, modest or moderate for values between 0.36 and 0.67, and strong or high for values of 0.68 and above (Taylor, 1990). The level of statistical significance was set at $p \leq .05$.

RESULTS

Table 1. *Descriptive characteristics of participants (n = 25).*

Variable	*Mean ± SD*
Age (years)	17 ± 0.9
Height (cm)	190.2 ± 7.8
Body Mass (kg)	81.3 ± 7.7
BMI (kg/m²)	22.1 ± 1.9
Dominant Leg Lean mass (kg)	12.26 ± 1.2
Jump Height	17.6 ± 3.9
Maximal force during the concentric phase	213.5 ± 28.4
Maximal force during the eccentric phase	178.6 ± 17.2

Descriptive characteristics of the participants were presented in Table 1. All variables (Dominant Leg Lean mass, Jump Height, Maximal force during concentric phase, Maximal force during eccentric phase) showed a normal distribution ($p > .05$). Specific p-values for the Shapiro-Wilk test ranged from $p = 0.22$ to $p = .57$. Furthermore, the variation analysis provided additional confirmation of the distribution shape. Skewness values ranged from -0.71 to 0.34, while Kurtosis values ranged from -1.55 to 1.04. The strongest relationship was found between dominant leg lean mass and Jump Height ($r = .67$, $p = .01$, $R^2=0.45$), maximal eccentric force ($r = .59$, $p = .04$, $R^2 = .35$), and for maximal concentric force ($r = .55$, $p = .05$, $R^2 = .30$). Results in Table 2 indicate that unilateral lean mass correlates with jump height and force production, particularly in the dominant leg. These findings confirm that higher segmental lean mass enhances explosive performance capacity, suggesting that specific strength training focused on unilateral lower-limb development may optimize power output among young basketball players.

Table 2. *Correlation between segmental lean mass and jump performance variables.*

	r	*p*
Dominant Leg Lean mass – Jump Height	.67	.01
Dominant Leg Lean mass – Maximal force during concentric phase	.55	.05
Dominant Leg Lean mass – Maximal force during eccentric phase	.59	.04

Note: $p < 0.05$ – significant correlation.

DISCUSSION

The aim of this study was to examine the relationship between the segmental lean mass of the lower limbs and vertical jump performance in young basketball players. The obtained results confirmed a significant positive association between the dominant leg lean mass and jump height, maximal concentric force, and maximal eccentric force during the countermovement jump ($p \leq .05$). These findings indicate that unilateral muscle distribution can influence explosive performance capacity, which aligns with previous research highlighting the importance of lower-limb muscle mass that correlate with jump performance (Xie et al., 2020).

Several studies have demonstrated that greater lean mass contributes to higher peak power and jump height (Almeida-Neto et al., 2020; Bell, Sanfilippo, Binkley & Heiderscheit, 2014). In a similar cohort of young male athletes (Bchini, Hammami, Selmi, Zalleg & Bouassida, 2023), studies have reported a very strong association between muscle volume and squat jump ($r = .70$; $p < .01$), CMJ ($r = .70$; $p < .01$), and CMJ with arms ($r = .55$; $p < .01$). However, the present study expands this evidence by showing that segmental lean mass also plays a decisive role in the efficiency of force generation. The dominant leg typically undergoes higher mechanical loading during sport-specific actions such as take-offs, cutting, and landings (Heshmati et al., 2025). This repeated loading could explain the higher lean mass and greater concentric force values found in the dominant limb. The correlation between lean mass and jump performance confirms the theoretical basis that muscle hypertrophy enhances contractile potential and elastic energy utilization (Cormie, McGuigan & Newton, 2011). However, beyond total muscle volume, the distribution and neuromuscular activation capacity of individual limbs may be more relevant for sport performance. Therefore, the findings of this study suggest that unilateral strength training focusing on isolated limb development could lead to more balanced and efficient force production, ultimately improving jump and sprint outcomes (Ramírez-Campillo et al., 2015; Pérez-Castilla et al., 2021)

From a practical standpoint, the results indicate that monitoring segmental lean mass may be a useful diagnostic tool for coaches to identify interlimb differences that could influence performance or increase injury risk. Incorporating unilateral resistance and plyometric exercises into regular strength programs may help to enhance functional power output, particularly during adolescent growth phases (McKinlay et al., 2018)

A limitation of this study is the small sample size, which may limit the generalizability of results. Nevertheless, the homogeneity of participants (age, training background, and competitive level) increases the internal validity of the data. Future longitudinal studies are highly recommended to explore the physiological mechanisms underlying the relationship between segmental strength, explosive jump performance, and changes in lean mass in youth athletes. These studies should also include neuromuscular parameters (tensiomyography or electromyography) to explain better the training-induced changes and their long-term effects on performance.

CONCLUSION

The study demonstrated a significant positive correlation between dominant leg lean mass and explosive jump performance among young basketball players. Specifically, greater lean mass in the dominant leg was associated with higher jump height and maximal concentric and eccentric force production. Monitoring muscle distribution may also assist coaches in identifying performance imbalances and preventing injuries.

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