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IMPACT OF MORPHOLOGICAL CHARACTERISTICS AND JUMPING ABILITY ON BLOCK JUMP HEIGHT

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ABSTRACT

This study investigated the combined impact of morphological characteristics and jumping ability on block jump height in volleyball. A sample of 28 elite male volleyball players, age 16.43 ± 2.47 years, was assessed using a battery of tests that measured nine variables, three of each category: anthropometry was evaluated via body height (BH), body mass (BM), and standing reach (REACH); jumping ability was evaluated via countermovement jump (CMJ), countermovement jump with arm swing (CMJA), and squat jump (SJ); block jump height was evaluated via two-foot jump block (BJTF), slide step jump block (BJSS), and crossover step jump block (BJCS). Descriptive statistics confirmed that the players' values aligned with normative data for their age group, and the assumption of normality of distribution was supported. Factor analysis revealed unidimensional constructs for anthropometry (explaining 74.46% of variance), jumping performance (95.69%), and block jump height (97.62%). A backward regression analysis demonstrated that both the anthropometry and jumping performance factors were significant predictors of block jump height ($R^2 = 0.855$, $p < .01$), with jumping performance exhibiting a slightly greater influence. These findings suggest that while both morphological characteristics and jumping ability are important, the capacity for explosive movement may be more critical for successful blocking in volleyball. Future research should consider larger and more diverse samples to further validate these results and refine training strategies aimed at enhancing block performance.

Key words: anthropometry, explosive strength, vertical performance,

blocking, effect

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INTRODUCTION

Volleyball is a dynamic and complex sport that demands the integration of various physical and technical skills to achieve optimal performance. Due to the nature of the sport, the athletes are required to the perform complex actions while keeping to the tactical plan of the game, which requires advanced cognitive abilities (Ilić, 2015). Anthropometric measurements such as body height, body weight, and standing reach are fundamental in volleyball (Konstantinos et al., 2019). These morphological characteristics are not only essential for player selection and position assignment (Tsoukos et al., 2019) but also serve as key determinants of an athlete's potential to excel in various aspects of the game (Giannopoulos et al., 2017). The inherent advantages conferred by favourable body dimensions are particularly important in actions requiring elevation and spatial coverage of the court (Nikolaidis et al., 2015).

Jumping ability represents a critical component of volleyball performance (Skazalski et al., 2018a; Rush et al., 2022). This capacity for explosive movement is indicative of explosive strength and coordination, both of which are indispensable for executing high-intensity plays (Ziv & Lidor, 2010). Superior jumping performance directly correlates with enhanced ability to perform rapid, forceful actions that are central to offensive and defensive manoeuvres in volleyball (Skazalski et al., 2018b).

Blocking stands as a cornerstone of defensive play in volleyball, playing a decisive role in preventing opponents from scoring (Araújo et al., 2010). The effectiveness of a block is linked to an athlete's block jump height, a performance metric influenced by both morphological attributes and explosive strength (Carvalho et al., 2020). A higher block jump height not only improves defensive coverage but also contributes to the overall tactical success of a team, underscoring the importance of this skill in the broader competitive framework (Silva et al., 2014).

The aim of this research is to determine the impact of morphological characteristics and jumping ability on block jump height.

METHODS

Participants

The research was conducted on 28 elite male volleyball players with a mean age of 16.43 ± 2.47 years. The players competed in the juniors age category, at the highest level for their age group. Prior to the experimental procedure, players, their legal guardians, and the coaching and medical staff received comprehensive written and verbal briefings regarding the study's procedures, risks, and benefits. Written consent for voluntary participation was obtained from both the players and their legal guardians. The inclusion criteria of the selected athletes were set at a minimum of five years of volleyball experience, training engagement of at least four times per week over the past year, and more than seven hours of weekly training. The players involved in this research had no pre-existing medical conditions, and currently didn't have any injuries nor were taking medications that could affect their participation

and performance. The study was conducted according to the principles of the Helsinki Declaration, as well as with the approval of the Ethics Committee of the Faculty of Sport and Physical Education, University of Niš.

Variables

Nine variables were analysed, three of each category.

Anthropometry variables:

- Body height (BH), expressed in cm.
- Body weight (BM), expressed in kg.
- Standing reach (REACH), expressed in cm.

Jumping performance variables:

- Countermovement jump (CMJ), expressed in cm.
- Countermovement jump with arm swing (CMJA), expressed in cm.
- Squat jump (SJ), expressed in cm.

Block jump height variables:

- Two-foot jump block (BJTF), expressed in cm.
- Slide step jump block (BJSS), expressed in cm.
- Crossover step jump block (BJCS), expressed in cm.

Procedures

All athletes were thoroughly briefed on the testing procedure. Each test was conducted in the team's training facilities, during the morning training session. Before the assessments, the players completed a 20-minute warm-up consisting of both general and volleyball-specific exercises.

Height and flat-footed standing reach measurements were taken with a precision of 0.1 cm using a Martin anthropometer (GPM, Switzerland). Body weight was measured with a precision of 0.1 kg using a calibrated balance scale (Avery Ltd, Model 3306 ABV). The jumping variables were measured using an optical sensor system with transmitting and receiving bars (Optojump, Microgate, Bolzano, Italy). The athletes made three attempts for each jump, with adequate recuperation between trials. Jump height was recorded after each trial and the highest recorded jump value was used for analysis. The reliability and validity of these tests have been established in previous research (Glatthorn et al., 2011).

Block jump height test was conducted utilising the battery of tests proposed by Nejić et al. (2016).

Statistical analysis

Descriptive parameters were calculated for all measured variables: minimum, maximum, mean, and standard deviation. The normality of the distributions was

verified using the Shapiro–Wilk test. Factor analysis was applied to all examined categories of variables in order to explain their underlying structure. The predictive impact of the anthropometry and jumping performance factors on block jump height factor was determined using backward regression analysis.

All statistical analyses were implemented in IBM SPSS Statistics (Version 25). The level of statistical significance was defined for the probability of 95% ($p \leq 0.05$).

RESULTS

Table 1 summarizes the descriptive analysis for all measured variables. The participants' body height (BH) ranged from 170.00 to 194.00 cm (M = 182.60, SD = 6.79), while body weight (BM) varied between 58.20 and 92.80 kg (M = 70.98, SD = 8.47). Standing reach (REACH) demonstrated a mean of 235.54 cm (SD = 9.94), indicating a relatively uniform distribution across the sample. Regarding jumping performance, the counter-movement jump (CMJ), counter-movement jump with arm swing (CMJA), and squat jump (SJ) yielded mean scores of 35.19 cm (SD = 5.73), 42.62 cm (SD = 6.54), and 31.94 cm (SD = 6.21), respectively. The block jump height measures, including the two-foot jump block (BJTF), slide step jump block (BJSS), and crossover step jump block (BJCS), exhibited mean values of 289 cm (SDs ranging from 12.336 to 13.952). Results presented in table 1 indicate that the volleyball players have the expected values of all examined parameters in regards of their age group. The Shapiro-Wilk tests for all variables ($p > .05$) supported the assumption of normality, thereby justifying the use of parametric statistical methods.

Table 1. Descriptive analysis

	N	Min	Max	Mean	SD	W	p
BH	28	170.00	194.00	182.596	6.788	.960	.343
BM	28	58.20	92.80	70.979	8.472	.949	.184
REACH	28	218.00	253.00	235.536	9.939	.964	.439
CMJ	28	27.30	51.30	35.186	5.731	.938	.097
CMJA	28	32.90	58.90	42.618	6.542	.949	.190
SJ	28	21.90	47.70	31.943	6.213	.927	.051
BJTF	28	262.00	306.00	288.607	12.336	.946	.153
BJSS	28	260.00	309.00	287.893	12.997	.964	.432
BJCS	28	262.00	312.00	290.286	13.952	.928	.056

Legend: N – number of participants; Min – minimum; Max – maximum; Mean – mean; SD – standard deviation; W - Shapiro-Wilk statistic; p - Shapiro-Wilk p-value; BH – body height; BM – body weight; REACH – standing reach; CMJ – countermovement jump; CMJA – countermovement jump with arm swing; SJ – squat jump; BJTF – two-foot jump block; BJSS – slide step jump block; BJCS – crossover step jump block.

Factor analyses were performed separately for the anthropometry, jumping performance, and block jump height variables to identify underlying latent constructs.

Table 2. Factor analysis of the anthropometry parameters

Variable	Factor
	1
BH	.945
BM	.677
REACH	.939
Eigenvalue	2.234
% of Variance	74.459
Cumulative %	74.459
KMO	.598

Legend: BH – body height; BM – body weight; REACH – standing reach

A unidimensional factor was extracted from BH, BM, and REACH, with an eigenvalue of 2.234 that accounted for 74.46% of the total variance (Table 2). The factor loadings were particularly robust for BH (0.945) and REACH (0.939), with BM also contributing a substantial loading (0.677). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.598, indicating a moderate level of appropriateness for the factor analytic procedure.

Table 3. Factor analysis of the jump parameters

Variable	Factor
	1
CMJ	.967
CMJA	.942
SJ	.962
Eigenvalue	2.871
% of Variance	95.688
Cumulative %	95.688
KMO	.776

Legend: CMJ – countermovement jump; CMJA – countermovement jump with arm swing; SJ – squat jump.

The factor analysis of CMJ, CMJA, and SJ revealed a single factor with an eigenvalue of 2.871, which explained 95.69% of the variance (Table 3). The loadings were exceptionally high (0.967 for CMJ, 0.942 for CMJA, and 0.962 for SJ), and the KMO value of 0.776 further substantiated the suitability of the data for this analysis.

Table 4. Factor analysis of the block jump height parameters

Variable	Factor
	1
BJTF	.988
BJSS	.990
BJCS	.986
Eigenvalue	2.929
% of Variance	97.619
Cumulative %	97.619
KMO	.789

Legend: BJTF – two-foot jump block; BJSS – slide step jump block; BJCS – crossover step jump block.

Similarly, the analysis of block jump parameters (BJTF, BJSS, BJCS) produced a single-factor solution with an eigenvalue of 2.929, accounting for 97.62% of the variance (Table 4). The factor loadings were uniformly high (ranging from 0.986 to 0.990), and the KMO measure was 0.789, suggesting that the sample was adequately suited for factor analysis in this domain.

Table 5. Linear regression analysis

Factors	Block jump height						
	B	SE	β	t	p	95% CI	
						LL	UL
Anthropometry	.529	.076	.529	6.917	<.001	.372	.687
Jump	.703	.076	.703	9.186	<.001	.545	.860

Notes.R^2 = .855, F(2,25)=74.00, p<0.01

To determine the predictive efficacy of the extracted factors from anthropometry measurements and jump performance on block jump height, a backward regression analysis was conducted. The overall model (Table 5) was statistically significant, ($F(2, 25) = 74.00$, $p < .01$), with an R^2 of .855, indicating that approximately 85.5% of the variance in block jump height was explained by the predictors.

Both independent variables contributed significantly to the model. The anthropometry factor yielded a regression coefficient (B) of 0.529 ($t = 6.917$, $p < .001$) with a 95% confidence interval ranging from 0.372 to 0.687. Likewise, the jump performance factor demonstrated an even stronger effect ($B = 0.703$, $t = 9.186$, $p < .001$) with a 95% confidence interval of 0.545 to 0.860.

DISCUSSION

The goal of this research is to determine the impact of morphological characteristics and jumping ability on block jump height. The results of the study indicate a complex interaction between anthropometric characteristics and jumping ability in determining block jump performance. Descriptive analysis shows the expected values of the anthropometric parameters for the volleyball male players of this age group (Popović-Ilić et al., 2011; Palao et al., 2014). The anthropometric values represent an important predictor when it comes to selection process and position assignment in youth volleyball age categories (Milić et al., 2017; Albaladejo-Saura et al., 2024). The body height and standing reach, as the two parameters of crucial importance to the block jump height, show average values for the volleyball male juniors category (Duncan et al., 2006).

The factor analysis results support the notion that, despite the distinct nature of the individual measures, a cohesive underlying construct can be identified within each domain. Specifically, the high loadings for body height and standing reach within the anthropometry factor underscore the importance of longitudinal dimensions (Toselli & Campa, 2018). The statistically significant correlation between body height, reach height and block jump reach has been established in volleyball players of junior age category (Legg et al., 2021; Karalić et al., 2023). The uniform contributions of all the jump tests within the jump factor reflect the integrated role of dynamic muscle actions (Sattler et al., 2012).

The findings obtained by regression analysis indicate that while both anthropometry and jumping ability are robust predictors of block jump height, jump performance exerts a slightly greater influence. The predominance of the jump factor in predicting block jump height suggests that explosive strength and power generation are critical determinants of on-court performance (Berriel et al., 2021).

The current findings resonate with previous research that has delineated the role of both morphological and strength factors in athletic performance. Prior studies in volleyball and other explosive sports have similarly reported that jumping performance metrics are robust predictors of game-specific skills such as block jump height and spiking ability (İşgüzar et al., 2023; Pawlik & Mroczek, 2023). In the study by Tsoukos et al. (2019), body height, the BMI and spike jump height successfully discriminated between selected and non-qualified elite young female junior national team volleyball players. The importance of countermovement jump with arm swing test was emphasised to have an important role in block jump height among male volleyball athletes (Sattler et al., 2015). Explosive strength jump training has shown statistically significant influence of the squat jump training regimen on block jump reach on both male and female volleyball players (Nasuka & Pradana, 2019). The available research also indicate that the jumping ability is just as important to consider as the body height and arm length when predicting block jump height (Palani et al., 2024).

The implications of the results in this research contribute to the evolving theoretical framework that integrates morphological characteristics and motor abilities as a comprehensive predictor of success in volleyball (D'Isanto et al., 2018; Albaladejo-Saura et al., 2023; Milić et al., 2024). The findings advocate for training regimens that prioritize the enhancement of explosive strength through plyometric and resistance exercises (Ramirez-Campillo et al., 2020).

Despite the compelling nature of these results, certain limitations should be acknowledged. It is plausible that other morphological and motor variables could also influence block jump performance (Horička et al., 2023). Additionally, the cross-sectional design limits the ability to infer causal relationships, and the relatively small sample size (N = 28) may restrict the generalizability of the findings to broader populations or different competitive levels. The fact that only male athletes were tested requires cation when drawing conclusions, given that past research identified different motor abilities between male and female volleyball players that contributed to the overall game performance, especially in the junior age category (Zwierko et al., 2023).

CONCLUSION

This study provides a comprehensive analysis of the joint influence of anthropometric characteristics and jump performance on block jump height in volleyball. The research findings indicate that while both constructs contribute significantly to block performance, the capacity for jump performance emerges as a more potent predictor of block jump height. These results underscore the importance of incorporating targeted plyometric and strength training interventions in volleyball conditioning programs. Future research should further validate these findings using larger and more diverse samples of volleyball players, including studies that examine potential differences across sex and age groups.

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