

Relationship between fundamental volleyball techniques and somatic indicators and types among volleyball players

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Published online: September 30, 2025

Accepted for publication: September 15, 2025

DOI:10.7752/jpes.2025.09205

Abstract:

Introduction. In this study, the relationship is examined between somatic structure and technical performance in men's volleyball, a sport requiring exceptional physical attributes, motor coordination and explosive actions such as spiking, blocking and serving. While serving and attacking are critical for scoring points, successful execution depends on contextual factors, i.e. reception quality, set type and anthropometric characteristics. In previous research, strong correlations have been demonstrated between somatotype, limb length and vertical jump ability—key determinants of both offensive and defensive performance. However, there remains a gap in understanding how detailed anthropometric indices influence volleyball-specific skills at the sub-elite level. **Materials and Methods.** The study included 37 male volleyball players competing in the second division of the Polish Volleyball Federation. Anthropometric measurements including Body Height (BH), Body Mass (BM), Torso Length (TL), Upper Limb Length (ULL) and Lower Limb Length (LLL)—were collected and used to calculate the following somatic indices: Upper Limb Length Index (ULLI), Lower Limb Length Index (LLLI), Torso Length Index (TLI), Body Mass Index (BMI) and Rohrer Index (RI). Match data were extracted using VolleyStation for the 2023/2024 season, covering key performance indicators such as attack, serve, block and reception efficiency. Descriptive statistics, Pearson's correlation coefficients and significance levels were computed to examine relationships between somatic structure and performance. **Results.** The analysis revealed that the athletic somatotype predominated among players, with relatively low variability in linear body proportions (ULLI, LLLI, TLI), suggesting selection bias towards somatic homogeneity. However, Body Mass and related indices (BMI, RI) showed greater variation, likely due to positional demands. Technical performance data indicated substantial variability in serving effectiveness ($V = 1.86$), reception quality ($\text{Exc\% } V = 0.80$), and break points ($V = 0.84$), suggesting high individual differentiation. Attack point efficiency ($\bar{X} = 6.81$; $\text{Pts\%} = 0.62$) was relatively consistent, underscoring the group's offensive strength. **Conclusions.** The findings allow to confirm that anthropometric traits, especially those related to limb proportions and body mass distribution, may influence specific volleyball skills. The predominance of athletic somatotype supports the significance of morphological profiling in player development. The variability in technical performance indicators highlights the need for individualized training and tactical adaptation. The results can provide information on talent identification, position-specific conditioning and optimization of skill acquisition in sub-elite male volleyball.

Key-words: volleyball, anthropometry, body composition, somatotype structure, performance statistics, skill efficiency

Introduction

Volleyball is a team sport characterized by explosive, high-intensity actions executed in rapid sequences lasting between 7 and 15 seconds, interspersed with short rest intervals typically lasting less than 20 seconds. This sport requires a high level of agility due to frequent and dynamic changes in movement patterns on the court, both in terms of direction and movement technique. Players must constantly adapt to rapidly changing game situations, requiring not only physical prowess but also sharp cognitive skills. Decision-making under pressure is a critical component, especially during fast-paced rallies. The sport emphasizes teamwork and communication, as successful plays often depend on precise coordination between teammates. Volleyball also demands advanced neuromuscular coordination, physical performance and motor control, with core actions including jumping, spiking, blocking and short sprints. Among these actions, the serve and attack are frequently identified as decisive for match outcomes. Tactical structures and game contexts, especially following reception or defensive sequences, significantly influence technical execution and the effectiveness of attacks. High-quality reception and fast tempo settings are key contributors to success in the side-out phase (Rocha et al., 2019; Pawlik et al., 2020; Lima et al., 2021; Puszczalowska-Lizis et al., 2024; Yu et al., 2025; Chen et al., 2025).

In volleyball, five positions are distinguished: setter, opposite hitter, outside hitter, middle blocker and libero. Each position on the court has distinct responsibilities that contribute to the overall strategy. The serve, as the only action in volleyball that does not depend on the opponent, initiates every rally and is considered a core

performance indicator, alongside the attack and block. Its objective is to score directly or disrupt the opponent's reception, thereby hindering their offensive strategy. The libero is the only player on the court who does not perform the serve during a match. Reception is a technical skill, the quality of which significantly affects the team's ability to set and execute an attack. Its efficacy is linked with the setter's position on the court at the moment of the serve. The setter has to evaluate the quality of the reception, position of the blockers and readiness of the attackers before making a decision. Quick sets to zone three or one are often used to speed up the offense and reduce the effectiveness of an opponent's block. Middle blockers rely on precise timing and visual cues from the setter to execute fast attacks, often referred to as "quick hits" or "first tempo" plays. Outside hitters are typically the most versatile attackers, capable of hitting from both the front and back row, and they often receive the highest number of sets. Opposite hitters are positioned to attack from the right side and are also responsible for blocking the opponent's outside hitter. Libero players specialize in ball control and are key in maintaining defensive stability, especially during long rallies. Defensive systems are built around anticipating the opponent's attack patterns and positioning players accordingly. Blocking techniques involve reading the hitter's shoulder and arm position to predict spike direction. Transition play, which refers to the shift from defense to offense, requires coordinated movement and rapid decision-making. Effective communication between players is essential to avoid positional overlaps and ensure tactical execution (López et al.; Millán-Sánchez et al., 2020; Baena-Raya et al., 2021; Costa et al., 2023; Bobula et al., 2024; Lacleto-Gutierrez et al., 2025).

The attack, as the final action in the sequence beginning with reception and followed by setting, plays a key role in point scoring. Its effectiveness is influenced by whether the ball is received from a serve or as a result of defensive action against an opponent's attack. A second critical factor is the nature of the set. A higher success rate has been observed following quick sets compared to conventional ones. Blocking is widely recognized as a critical defensive component in elite-level volleyball. Its effectiveness is shaped not only by the tactical decisions of the opposing setter, but also by the anticipation and decision-making of the middle blocker. Reach jump ability plays a vital role in both attack and block performance. Moreover, blocking is the technical element most strongly associated with winning outcomes (Cojocarui et al., 2018; Xu et al., 2020; Afonso et al., 2021; de Leeuw et al., 2022; Cieśluk et al., 2023; Polychronopoulos et al., 2025).

As the sport is becoming increasingly competitive, coaches and sports scientists are seeking more precise methods to evaluate and develop player potential. Despite advancements in performance analysis, there remains a noticeable gap in research connecting somatic characteristics with technical execution in volleyball. Existing literature is often focused on general fitness or isolated skill assessments, without considering the influence of body type on specific actions in volleyball. This study was carried out in response to the lack of specialized data that could support coaches in making informed decisions about player roles, training priorities and long-term development strategies. By analyzing somatotypes and anthropometric indicators, the present research aims to bridge the gap between physical profiling and performance outcomes. Modern volleyball has evolved with the introduction of advanced analytics and video analysis, allowing teams to study opponents' tendencies and refine their own tactics. Coaches use data to optimize rotations, serving strategies and defensive formations. The speed of the game has significantly increased over the years, with top-level teams executing attacks in under a second after reception. Achieving high-level performance in volleyball is closely associated with specific anthropometric characteristics, body composition and motor abilities, all of which may vary depending on competition level. Each sport is characterized by a unique morphological profile among its athletes, adapted to the specific physical and technical demands of the discipline. In volleyball, optimal performance depends on a combination of strength, speed, coordination and somatic factors, such as limb length or muscle mass distribution. Evidence suggests that anthropometric variables may account for up to 83% of the variance in vertical jump height, which is a fundamental ability in both attack and block execution. These skills are highly position-specific. For instance, middle blockers—who execute the majority of block actions—require physical attributes which would support this role, such as greater height and reach. In research, it has been indicated that the ectomorphic somatotype is most common among elite middle blockers, while setters more frequently exhibit a mesomorphic profile. Players in the remaining positions tend to display body types that fall between ectomorph and endomorph (Bojanic et al., 2020; Baena-Raya et al., 2021; Grigoletto et al., 2023; Milić et al., 2024).

The aim of the study is to extend knowledge on somatotypes occurring among volleyball players, supplement information on body length measurements and determine the influence of somatic structure on selected technical elements in men's volleyball. The research was necessary due to the lack of specialized analyses focusing on the relationship between somatic body types and technical performance in volleyball. Despite the sport's growing popularity and increasing physical demands, the scientific volleyball community still lacks advanced studies connecting anthropometric characteristics with skill execution. This gap in knowledge limits coaches' ability to identify and develop player potential based on body structure. By providing detailed insights into somatotypes and their influence on performance, practical tools for talent identification and individualized training are offered in this study. Unlike general fitness assessments, this research targets volleyball-specific actions such as spiking, blocking and serving, making it highly relevant for professional development. Coaches can use the findings to optimize player roles and tactical decisions, enhancing team

efficiency. Moreover, the study contributes to evidence-based coaching by integrating biomechanical and physiological data into training strategies. The absence of such targeted research has made it difficult to objectively evaluate how body composition affects performance outcomes. Therefore, this study fills a critical gap and lays the foundation for future investigations in volleyball science. The analysis revealed a predominance of mesomorphic somatotypes, which are typically associated with a muscular build and explosive power. This body type is particularly advantageous in volleyball due to the frequent need for performing jumps, sprints and rapid changes in direction. Anthropometric measurements, such as arm span, leg length and vertical reach, were found to have a strong correlation with performance in spiking and blocking. Players with longer limbs and greater reach demonstrated superior effectiveness in net-based actions. Body mass distribution and movement efficiency during defensive transitions were also examined in this study. A balanced somatic profile may lead to better agility and reduced risk of injury. The authors emphasized the importance of individualized training programs that would take somatotype-specific strengths and limitations into consideration. Technical elements were analyzed in relation to anthropometric features. Serve velocity and jump height were among the key performance indicators linked to body composition. Overall, the study contributes to a more nuanced understanding of how physical characteristics influence skill performance in elite men's volleyball. In order to achieve the study objective, the authors identified the most common somatotypes among volleyball players, analyzed indicators of somatic structure having influence on selected technical elements in men's volleyball and determined the level of BMI characteristic of this group of athletes.

Materials and methods

The study participants comprised volleyball players from the second division of the Polish Volleyball Federation (AKS V LO Rzeszów, KS Błękitni Ropczyce, Avia Solar Sędziszów Małopolski). The study group consisted of 37 men. The research was approved by the Ethics Committee of the University of Rzeszów, Poland and was conducted according to the ethical standards of the Committee on the Rights of Experiments under the 1964 Declaration of Helsinki. The average age of the study group was 23.32 ± 6.00 years. Body height among the players averaged 190.9 ± 7.6 cm and body mass was at 86.89 ± 10.29 kg. The athletes underwent the following measurements before training and at a similar time in the evening: Body Height (BH), Body Mass (BM), Torso Length (TL), Upper Limb Length (ULL) and Lower Limb Length (LLL). Length measurements were taken using an anthropometer. The right limb was considered for all measurements. Body mass was measured using the Tanita body composition analyzer (DC-430MA). The following anthropometric points were determined for length measurements: Vertex, Acromiale, Trochanterion, Suprasternale and Symphision. The measurement of body height was taken between the Vertex and Basis points. Upper Limb Length (ULI) was measured between the Acromial and Dactylion (III) points. Torso Length (TL) was measured between the points of the Suprasternale and Symphision, and the lower limb length (LLL) between the Trochanterion and Basis. The collected results were used to determine the following coefficients: Upper Limb Length Index (ULLI), Lower Limb Length Index (LLLI), Torso Length Index (TLI), Body Mass Index (BMI) and Rohrer Index (RI). These calculations were carried out based on the formulas given below:

$$\begin{aligned} ULLI &= \frac{ULL}{\frac{BH}{LLL}} * 100 \\ LLLI &= \frac{LLL}{\frac{BH}{TL}} * 100 \\ TLI &= \frac{TL}{BH} * 100 \end{aligned} \qquad \begin{aligned} BMI &= \frac{BM}{BH^2} \\ RI &= \frac{BM}{BH^3} \end{aligned}$$

(Kamińska, 2020).

According to the classification proposed by Kamińska (2020), the Upper Limb Length Index (ULLI) denotes a short upper limb if the value is below 44.9. A value between 45.0 and 46.9 indicates a medium-length upper limb, whereas a value above 47.0 signifies a long upper limb. The Lower Limb Length Index (LLLI) reflects a short lower limb if the result is less than 50.0. Values ranging from 50.1 to 52.2 correspond to a medium-length limb, while a result exceeding 52.3 indicates a long lower limb. The Torso Length Index (TLI) identifies a short torso when the value is below 29.5. A medium torso is defined by a value between 29.6 and 31.2, and a value above 31.3 represents a long torso. The Body Mass Index (BMI) indicates severe undernutrition when the value is below 16.0. A value between 16.0 and 16.99 reflects underweight, while a BMI between 17.0 and 18.49 is classified as overweight. A normal BMI falls within the range of 18.5 and 24.99. Values between 25.0 and 29.99 indicate overweightness. Obesity is classified into three grades: Grade I (30.0-34.99), Grade II (35.0-39.99) and Grade III, which includes values above 40.0. The Rohrer's Index (RI) indicates a slender body build when the value is below 1.24. A value between 1.25 and 1.35 represents a medium build, while a value above 1.37 is characteristic of a robust body build (Kamińska, 2020).

Statistical Match reports, taking the basic technical elements in men's volleyball into account, were compiled in VolleyStation. All these matches were played in the 2023/2024 season. The following statistics were considered: total points (Tot), break points (BP), surplus of points won over points lost (W-L), total receptions (Tot), reception errors (Err), positive receptions (Pos%), perfect receptions (Exc%), total points scored by block

(Tot), number of services performed (Tot), service errors (Err), service points (Pts), total attacks performed (Tot), attack errors (Err), blocked attacks (Blo), total points scored by attack (Pts) and attack efficiency (Pts%). The data, both those on somatic structure and those collected during the matches, were analyzed using the programs: MS Excel and GNU PSPP. The minimum, maximum, coefficient of variation, mean and standard deviation were determined. In order to further analyze the data, Pearson's linear correlation coefficient (r) and the statistical significance coefficient (p) between somatic structure indices as well as basic technical elements in volleyball were determined.

Results

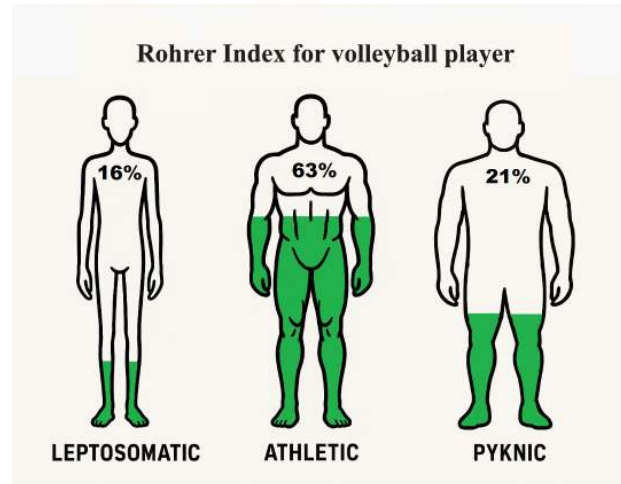


Fig. 1. Somatotype characteristics among study group.

Classification of the study group, according to the Rohrer index which is based on Kamińska's classification into three primary somatotypes, in line with the typology proposed by Kretschmer: leptosomatic, pyknic, and athletic, is illustrated in Figure 1. The athletic somatotype clearly predominated as the somatic structure of volleyball players.

Table 1. Statistical characteristics of selected anthropometric measurements

	BH [cm]	BM [kg]	ULL [cm]	LLL [cm]	TL [cm]	ULLI [cm]	LLLI [cm]	TLI [cm]	BMI [cm/kg ²]	RI [g/cm ³]
$\bar{X}$	191.00	86.89	79.25	96.47	54.75	41.50	50.54	28.68	23.83	1.25
SD	8.00	10.29	4.04	4.74	3.03	0.99	1.93	1.17	2.41	0.14
Min	179.00	62.00	72.40	88.90	50.70	39.41	46.13	26.32	17.73	0.95
Max	205.00	108.00	87.80	109.00	62.20	43.23	53.96	31.09	29.30	1.58
V	0.04	0.12	0.05	0.05	0.06	0.02	0.04	0.04	0.10	0.11
BH – Body Height; BM – Body Mass; ULL – Upper Limb Length; LLL – Lower Limb Length; TL – Torso Length; ULLI – Upper Limb Length Index; LLLI – Lower Limb Length Index; TLI – Torso Length Index; BMI – Body Mass Index; RI – Rohrer Index										

In Table 1, descriptive statistics are presented for selected anthropometric indices among volleyball players. The analyzed sample exhibits characteristic somatic features typical of this sport. Volleyball players are primarily distinguished by their Body Height (BH) ($\bar{X}$ = 191.00 cm; SD = 8.00; min = 179 cm; max = 205 cm), a trait influenced by sport-specific selection criteria. Body proportions, including Upper Limb Length Index (ULLI) ($\bar{X}$ = 41.50; SD = 0.99; V = 0.02), Lower Limb Length Index (LLLI) ($\bar{X}$ = 50.54; SD = 1.93; V = 0.04) and Torso Length Index (TLI) ($\bar{X}$ = 28.68; SD = 1.17; V = 0.04) show low coefficients of variation, indicating a high degree of homogeneity in body structure within the study group.

This uniformity may result from intentional selection for optimal proportions advantageous in volleyball. Body Mass (BM) demonstrates greater variability compared to the aforementioned indices ($\bar{X}$ = 86.89 kg; SD = 10.29; min = 62.00 kg; max = 108.00 kg; V = 0.12), which may be attributed to differences in body mass associated with playing positions. Body Mass Index (BMI) ($\bar{X}$ = 23.83; SD = 2.41; V = 0.10) and Rohrer Index (RI) ($\bar{X}$ = 1.25; SD = 0.14; V = 0.11) suggest the presence of diverse somatotypes among the athletes. The combination of low variability in linear body dimensions (ULL, LLL, TL) and higher variability in mass-related indices (BM, BMI, RI) underscores the significance of proportional growth-based selection, individual differences in training adaptations and physiological development affecting the body composition of volleyball players.

Table 2. Statistical characteristics of basic technical elements in volleyball

	Points		Reception				Block	Serve			Attack				
	Tot	BP	Tot	Err	Pos%	Exc%	BPts	Tot	Err	SPts	Tot	Err	Blo	APts	Pts%
$\bar{X}$	9.44	4.19	18.64	0.64	0.41	0.26	1.56	12.75	1.75	1.06	13.56	1.44	1.13	6.81	0.62
SD	6.00	3.51	15.94	0.67	0.25	0.21	1.41	5.60	1.69	1.29	11.34	1.75	2.09	5.06	0.27
Min.	3.00	1.00	1.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	1.00	0.00	0.00	1.00	0.14
Max.	21.00	13.00	49.00	2.00	0.69	0.63	4.00	21.00	6.00	4.00	35.00	5.00	8.00	16.00	1.00
V	0.64	0.84	0.86	1.06	0.60	0.80	0.90	0.44	0.97	1.21	0.84	1.22	1.86	0.74	0.43

Tot. – Total; BP – total Break Points won; Err. – Error; Pos% – reception resulting in at least few attack options; Exc% – reception resulting in all possible attack options; BPts – Block Points; SPts – Serve Points; APts – Attack Points; Blo – Blocked; Pts% – Points displayed as percentage of Total

The data given in Table 2 reveal some differences in the level of technical efficiency among male volleyball players. Elements such as the number of points scored ($\bar{X} = 9.44$; SD = 6.00; V = 0.64), service effectiveness (points scored directly from serve: $\bar{X} = 1.06$; SD = 1.29; V = 1.21) and reception quality (Exc% = 0.26; SD = 0.21; V = 0.80) show high variability, which may reflect positional specialization and individual technical predispositions. High variability is also observed in Break Points ($\bar{X} = 4.19$; SD = 3.51; V = 0.84), points scored following one's own serve, and in the number of service errors ($\bar{X} = 1.75$; SD = 1.69; V = 0.97), indicating a highly diverse level of risk taken by players while performing a serve. Particularly noteworthy is the broad range of effectiveness in both serving (maximum number of aces = 4) and reception (Pos% = 0.41; SD = 0.25; V = 0.60), suggesting the critical role of these elements in building a point advantage and maintaining offensive continuity. In contrast, attack point efficiency ($\bar{X} = 6.81$; SD = 5.06; V = 0.74) and relative attack effectiveness (Pts% = 0.62; SD = 0.27) indicate a high offensive value of this player group, accompanied by moderate variability, which may suggest consistency in the execution of this element at such a level. These data may serve both as a basis for planning individualized technical training and for assessing a player's suitability for specific team positions. The high coefficients of variation in selected variables (Exc%: V = 0.80; BP: V = 0.84; Aces: V = 1.21) confirm the importance of personalizing the training process and adapting match strategies to players' individual technical capabilities.

Table 1. Pearson's linear correlation coefficients (r) between selected technical elements in volleyball and indicators of somatic structure

	ULLI	LLLI	TLI	BM	BH	BMI	RI
Tot	-0.02 $p=0.940$	0.46 $p=0.097$	-0.04 $p=0.905$	0.21 $p=0.481$	0.25 $p=0.398$	0.03 $p=0.932$	-0.09 $p=0.771$
SPts	-0.09 $p=0.773$	0.36 $p=0.200$	-0.33 $p=0.248$	-0.24 $p=0.407$	-0.25 $p=0.396$	-0.11 $p=0.716$	-0.01 $p=0.983$
BPts	-0.23 $p=0.431$	0.62 $p=0.018$	0.00 $p=0.992$	-0.04 $p=0.882$	-0.03 $p=0.92$	-0.03 $p=0.912$	-0.01 $p=0.960$
APts	0.06 $p=0.853$	0.31 $p=0.281$	0.04 $p=0.884$	0.33 $p=0.253$	0.37 $p=0.188$	0.07 $p=0.818$	-0.10 $p=0.734$
APts%	-0.16 $p=0.591$	-0.21 $p=0.469$	0.09 $p=0.769$	0.32 $p=0.263$	0.04 $p=0.888$	0.42 $p=0.137$	0.37 $p=0.194$
Pos%	0.34 $p=0.339$	0.44 $p=0.199$	0.09 $p=0.815$	0.25 $p=0.483$	-0.05 $p=0.893$	0.44 $p=0.203$	0.33 $p=0.346$
Exc%	0.28 $p=0.429$	0.66 $p=0.038$	-0.01 $p=0.987$	0.49 $p=0.150$	0.09 $p=0.802$	0.60 $p=0.068$	0.39 $p=0.271$
BP	-0.30 $p=0.306$	0.37 $p=0.199$	-0.06 $p=0.851$	-0.07 $p=0.825$	-0.11 $p=0.704$	0.01 $p=0.976$	0.05 $p=0.879$
W-L	-0.18 $p=0.538$	0.12 $p=0.673$	0.00 $p=0.994$	0.24 $p=0.403$	0.17 $p=0.568$	0.14 $p=0.646$	0.04 $p=0.888$

Tot. – Total; Spts – Serve Points; Bpts – Block Points; Apts – Attack Points; Apts% – Attack Points displayed as percentage of Total; Pos% – reception resulting in at least few attack options; Exc% – reception resulting in all possible attack options; BP – total Break Points won; W-L – surplus of points won over points lost; ULLI – Upper Limb Length Index; LLLI – Lower Limb Length Index; TLI – Torso Length Index; BM – Body Mass; BH – Body Height; BMI – Body Mass Index; RI – Rohrer Index

Pearson's linear correlation coefficients (r) between selected technical performance variables and indicators of somatic structure are shown in Table 3. Additionally, the statistical significance (p-value) was calculated. Two strong correlations were found between technical performance and somatic indicators. The first was between Bpts and LLLI ($r = 0.62$, $p = 0.018$) and the second, between Exc% and LLLI ($r = 0.66$, $p = 0.038$).

Discussion

In recent studies, the role of somatic structure has been increasingly emphasized for determining performance in volleyball, particularly in relation to technical elements such as serving, blocking, attacking and reception. Anthropometric characteristics such as Body Height (BH), Limb Length (ULL, LLL) and Body Mass Index (BMI) have been shown to influence the effectiveness of these skills in adult male players. In the research, the average body height (191.00 cm) and body mass (86.89 kg) of the players align with the profiles of elite-level male volleyball athletes, as reported in recent literature. These somatic traits are often associated with enhanced reach and power, which are critical in volleyball actions (Chatterjee; Bandyopadhyay, 2022; Musa et al., 2022; Caparello et al., 2023; Grigoletto et al., 2023; Sarafyniuk et al., 2024). Pena et al. conducted measurements regarding the anthropometric parameters of volleyball players aged 27.9 ± 4.9 years, with the average age of the study group being 23.32 ± 6.00 years, average height at 193.23 cm, and the average body mass totaling 88.49 kg. The group of Polish volleyball players had an average height of 191.00 ± 8.007 cm and an average body mass of 86.89 ± 10.29 kg. Petroski et al. analyzed the somatic structure of Brazilian volleyball players, for whom the average body mass was 90.3 ± 13.0 kg, average height, 197.0 ± 8.0 cm, and the BMI equaled 23.2 ± 2.3 . Campa et al. studied volleyball players aged 25.62 ± 4.74 years. In this group, the average height was 195.28 ± 8.31 cm and average body mass 90.50 ± 9.08 kg, while the BMI was 23.72 ± 1.78 . Shchepotina et al. evaluated the somatic structure of volleyball players, among which the average age totaled 22.92 ± 5.22 years, the average height was 198.05 ± 6.00 cm, average body mass, 90.49 ± 11.83 kg, and the BMI was 23.06 ± 2.46 . Giannopoulos et al. assessed volleyball players from the two highest leagues, where the average age was 27.50 ± 5.50 years, the average height was 193.55 ± 6.48 cm, the average body mass 91.50 ± 9.91 kg, and BMI, 24.41 ± 2.20 . Toselli and Campa examined the somatic structure of volleyball players, the average age being 27.53 ± 5.2 years, average body mass, 88.75 ± 9.0 kg, and the BMI was 23.53 ± 1.99 (Petroski et al., 2013; Giannopoulos et al., 2017; Peña et al., 2018; Toselli; Campa, 2019; Shchepotina et al., 2021).

Gaurav and Singh analyzed the somatic structure of volleyball players aged 18–25 years participating in university competitions in India. The average age was 23.32 ± 6.00 years, the average height 184.45 ± 8.87 cm, and the average body mass 73.39 ± 9.1 kg, with the BMI at 21.5 ± 2.18 . The average arm length was 81.4 ± 4.04 cm, and the average leg length 103.85 ± 6.12 cm. The studied subjects demonstrated a higher average body mass of 86.89 ± 10.29 kg, they were taller (191.00 ± 8.00 cm), had a higher BMI (23.83 ± 2.41), but shorter upper (79.25 ± 4.04 cm) and lower limbs (96.47 ± 4.74 cm). Raschka and Dierer examined the somatic structure of volleyball players from the German league. Their average age was 29.8 ± 11.0 years, the average height was 189.3 ± 7.0 cm, average body mass, 80.2 ± 10.3 kg, and the BMI equaled 22.3 ± 2.3 . The subjects in the current study had a higher average height (191.00 ± 8.00 cm), body mass (86.89 ± 10.29 kg) and BMI (23.83 ± 2.41). The average upper limb length in the German group was 82.0 ± 3.6 cm, and the average lower limb length, 90.8 ± 5.5 cm. In the study group, the upper limb length was lower (79.25 ± 4.04 cm), while the lower limb length was higher (96.47 ± 4.74 cm). The somatic type in the German group was mainly leptosomatic, however, in the study group, it was athletic. Wnorowski and Cieminski analyzed the somatic structure of volleyball players from the FIVB 2014 World Championships. The average age was 26.53 ± 3.9 years, average height totaled 198.41 ± 6.05 cm, the average body mass 89.4 ± 8.43 kg, and the Rohrer index was 1.15 ± 0.1 . In the study group, the average age was 23.32 ± 6.00 years, average height 191.00 ± 8.00 cm, average body mass was 86.89 ± 10.29 kg, and the Rohrer index equaled 1.25 ± 0.14 . The leptosomatic type was present in 90.36% of the subjects in the championships, and the athletic type, in 9.28%. In the study group, the athletic type was present in 63%, the pyknic type in 21%, and the leptosomatic type in 16% (Gaurav; Singh, 2014; Wnorowski; Cieminski, 2016; Raschka; Dierer, 2020).

The significant correlation between the Lower Limb Length Index (LLLI) and excellent reception percentage (Exc%, $p = 0.038$) suggests that players with proportionally longer lower limbs may possess biomechanical advantages in stabilizing their posture and adjusting body position during reception. This aligns with the findings of Francisco Esparza-Ros and Raquel Vaquero-Cristóbal, who emphasized that proportionality—particularly in limb-to-torso ratios—can influence technical execution in dynamic sports such as volleyball, where rapid changes in body orientation are required. This may indicate that players with longer lower limbs can better position themselves and stabilize their posture during reception, improving technical execution. However, no significant correlations were found between Upper Limb Length Index (ULLI) and any of the performance indicators, suggesting that lower limb proportions may play a more decisive role in adult male volleyball performance. Moreover, Silva et al. (2020) noted that anthropometric characteristics, such as limb length and body segment ratios, are predictive of technical performance in youth volleyball players, particularly in reception and defensive actions. These findings reinforce the idea that reception efficiency is not solely a matter of skill, but also of structural predisposition, which can be optimized through targeted training and talent identification strategies (Silva et al., 2014; Araújo et al., 2020; Silva et al., 2020; Esparza-Ros; Vaquero-Cristóbal, 2023; Bobula et al., 2024). Correlation analysis revealed a statistically significant positive relationship between the Lower Limb Length Index (LLLI) and Block Points (BPs, $p = 0.018$), potentially meaning that players with proportionally longer lower limbs tend to perform better in blocking. This is consistent with the findings of such researchers as Malousaris et al. (2021), who highlighted the significance of lower limb leverage in vertical jump height and block timing (Peña; Casals, 2016; Pawlik et al., 2020; Malousaris et al.

2021; Cieśluk et al., 2023; Polychronopoulos et al., 2025). Monteiro et al. analyzed the reception and attack efficiency of volleyball players participating in the 2007 World Championships in Japan, where the attack efficiency was 49%. In the studied group, the attack efficiency was significantly higher at 62%. Positive reception throughout the tournament averaged at 40%, and perfect reception was at 20.7%. In a group of players from the Subcarpathian region, the positive reception efficiency was 41%, and the perfect reception was 26%, indicating better results in this group. Marcelino et al. examined the impact of attack tempo on the probability of scoring points, calculating the average attack efficiency at $48.11 \pm 6.51\%$, with a minimum of 32.10% and maximum of 70.91%. In the studied group, the attack efficiency was $62.06 \pm 26.53\%$, with a minimum value of 14% and a maximum of 100%. Afonso et al. analyzed the average attack efficiency of players, which was 46%; while in the studied group, the efficiency was significantly higher, averaging 62% (Afonso et al., 2005; Marcelino et al., 2008; Monteiro et al., 2009). Variability coefficients (V) indicate high inter-individual differences in technical performance, particularly in serve and attack efficiency. This variability may be partially explained by differences in somatic structure, but also by factors such as training history, tactical role and psychological readiness, which were not assessed in this study. Interestingly, although BMI and Rohrer Index (RI) varied among players, they did not show strong correlations with technical performance. This supports the notion that body composition alone is not a sufficient predictor of skill execution, and that segmental proportions (e.g. limb-to-torso ratios) may be more relevant. In conclusion, the findings support the growing body of evidence that specific somatic indicators, particularly lower limb proportions, are associated with superior performance in key volleyball skills. These insights may provide information for talent identification and individualized training programs, emphasizing the development of biomechanical advantages rooted in body structure (Sterkowicz et al., 2000; Tomaszewski et al., 2011; Giannopoulos et al., 2017; Đurković et al., 2023).

Conclusions

In the present study, it was demonstrated that somatic structure and selected anthropometric indices exert significant influence on technical performance in men's volleyball. The predominance of the athletic somatotype (61%) among the examined players highlights the importance of morphological profiling in volleyball-specific selection processes, while the observed variations in body mass indices reflect positional demands and individual adaptations. Notably, the Lower Limb Length Index (LLLI) showed strong correlations with block effectiveness ($r = 0.62$; $p = 0.018$) and reception quality ($r = 0.66$; $p = 0.038$), indicating that lower-limb proportions play a decisive role in both offensive and defensive efficiency. These results suggest that volleyball performance cannot be fully explained by technical skills alone, but rather that it is also shaped by structural predispositions determining the capacity to execute complex game actions. The findings of the study suggest that somatic structure plays a significant role in influencing technical performance in men's volleyball. From a practical standpoint, valuable tools for coaches are offered in this study, enabling them to assess and compare player performance in match conditions and to use somatic data to make decisions about team composition and player development. Ultimately, these insights can support more targeted and effective coaching approaches, contributing to improved performance and strategic planning in senior volleyball teams.

The relevance of these findings to the business of professional volleyball—particularly in team management, talent scouting and performance optimization—is substantial. By identifying measurable physical traits that correlate with specific technical skills, teams can make more informed decisions when recruiting players or designing individualized training programs. For example, knowing that lower limb length significantly affects blocking and reception performance allows coaches and sports scientists to prioritize certain anthropometric features during player evaluations. This data-driven approach can enhance team competitiveness, reduce trial-and-error in player development, and ultimately, improve match outcomes, which is crucial among clubs aiming for high performance and return on investment.

This study contributes to volleyball science by reinforcing the link between anthropometric structure and skill execution, thereby providing empirical support for models that integrate morphological, biomechanical and tactical determinants of performance. The findings broaden the current understanding of how physical predispositions underpin the execution of technical elements, particularly in sub-elite male players. The significance of this work is further underscored by its implications for future research and practical applications. Encouraged are the integration of biometric and performance analytics into routine coaching practices, paving the way for more sophisticated models of player assessment. Future studies could expand on these findings by exploring how somatic structure interacts with psychological and tactical factors or by developing predictive tools that help forecast a player's potential based on physical metrics. Such advancements would not only refine talent identification but also contribute to long-term, strategic planning in professional volleyball organizations.

The practical implications of these findings are considerable. Coaches and performance analysts may employ anthropometric profiling not only for talent identification and positional allocation, but also for the design of individualized training regimens and tactical strategies aligned with specific somatic characteristics. For instance, players with proportionally longer lower limbs may be systematically developed and positioned to maximize blocking and reception outcomes, while body mass and BMI monitoring can inform conditioning practices aimed at preserving both agility and vertical jumping ability. Such evidence-based applications can improve player evaluation, long-term development planning and overall team efficiency.

Conflicts of interest

The authors declare that there are no conflicts of interest associated with the preparation, execution or publication of this study. No personal, professional or financial relationships exist that could have influenced the objectivity or integrity of the research.

Limitations

The study's limitations point to future research directions. Larger and more diverse samples, inclusion of elite-level athletes and integration of biomechanical or physiological variables would strengthen the generalizability and explanatory scope of the findings. Longitudinal approaches could further clarify how somatic factors interact with training adaptations throughout a player's career, offering deeper insights into the long-term development of volleyball performance.

Funding source

This research was financed entirely from the authors resources. No external funding, sponsorship or institutional financial support was received for conducting this study.

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