

The Importance of Body Height and Arm Span in the Development of Young Athletes: A Comparative Analysis of Soccer, Basketball, and Volleyball

Importancia de la Estatura y la Envergadura en el Desarrollo de Jóvenes Atletas: Un Análisis Comparativo de Fútbol, Baloncesto y Voleibol

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SUMMARY: The aim of this study was to analyze and compare body height and arm span among youth athletes in soccer, basketball, and volleyball, emphasizing their practical significance in player selection, positioning, and training process adaptation. The sample consisted of 46 elite youth athletes divided into three groups: soccer players (n = 21), volleyball players (n = 9), and basketball players (n = 16). Anthropometric measurements were collected using standardized ISAK protocols and analyzed through ANOVA with Bonferroni post hoc testing. The results indicated statistically significant differences in body height and arm span between soccer players and athletes from the other two groups ($p < .001$). Volleyball and basketball players were significantly taller and had greater arm spans compared to soccer players. These differences reflect the specific morphological demands of each sport—vertical sports such as basketball and volleyball favor increased height and reach, whereas soccer emphasizes agility and a lower center of gravity. The findings highlight the importance of incorporating anthropometric profiling into early talent identification and individualized training planning. Coaches and strength and conditioning professionals can utilize these data to optimize player development and improve selection criteria. Furthermore, understanding these morphological distinctions can assist in directing young athletes toward sports that best align with their physical attributes. This research contributes to the growing body of evidence supporting the relevance of sport-specific morphological profiling as a foundation for long-term success in sport.

KEY WORDS: Morphological characteristics; Talent identification; Growth and development; Physical performance; Team sports.

INTRODUCTION

The morphological characteristics of athletes represent a crucial aspect in the analysis of sports abilities, selection processes, and functional preparation. Body height and arm span, as stable anthropometric dimensions, are often considered key selection criteria in certain sports disciplines, especially in team sports (Carter & Heath, 1990; Norton & Olds, 2001), where they play a fundamental role in contemporary sports practice. These body dimensions are frequently associated with the specific demands of various sports, and their analysis holds significant relevance for the selection process, positional allocation, and individualization of training protocols (Carter & Heath, 1990).

Sports such as basketball and volleyball involve frequent vertical actions, where greater body height and limb length facilitate the execution of technical and tactical tasks such as jump shots, blocking, spiking, and ball interception (Malousaris *et al.*, 2008; Ziv & Lidor, 2010). In contrast, soccer is characterized predominantly by horizontal movement patterns, with emphasis on speed, agility, and endurance, where body height and arm span are mostly relevant for goalkeepers and defenders (Reilly *et al.*, 2000; Malina *et al.*, 2004), particularly in aerial duels and set-piece situations (Ziv & Lidor, 2010).

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Arm span, which often correlates with body height, is also considered a biomechanical efficiency indicator in movements that require body extension, such as jumping, blocking, and ball contact at higher spatial points (Gaurav *et al.*, 2010). Therefore, understanding the differences in body height and arm span among athletes from different sports may contribute to more effective talent selection, better orientation of athletes toward disciplines that match their physical predispositions, and the development of optimized training protocols aligned with the morphological demands of each sport.

The aim of this study was to analyze and compare body height and arm span among youth athletes in soccer, basketball, and volleyball, emphasizing their practical significance in player selection, positioning, and adaptation of the training process. Through a comparative approach, the study seeks to highlight the differences in morphological demands across these sports and the practical application of these insights in working with youth athletes.

MATERIAL AND METHOD

Sample of participants. The research was conducted on a sample of 46 elite youth athletes, divided into three sub-samples. The first sub-sample consisted of soccer players ($n = 21$; body height: 176.40 ± 7.56 cm; body mass: 66.49 ± 11.08 kg; body fat: 8.59 ± 3.35 %). The second sub-sample included volleyball players ($n = 9$; body height: 187.05 ± 6.15 cm; body mass: 72.15 ± 8.81 kg; body fat: 8.20 ± 3.00 %). The third sub-sample consisted of basketball players ($n = 16$; body height: 185.15 ± 6.34 cm; body mass: 73.26 ± 7.33 kg; body fat: 8.82 ± 2.16 %). At the time the study was conducted, this league represented the highest competitive level for elite youth athletes in Montenegro. The research was carried out in accordance with the conditions of the declaration of Helsinki.

Research Design

Anthropometry. All anthropometric assessments were conducted following the standardized methodology outlined by the International Society for the Advancement of Kinanthropometry (ISAK).

Body height. Body height was measured using a portable stadiometer (SECA 213, Germany), from the vertex of the head to the floor, with the subject in the anatomical position and aligned to the Frankfurt plane. Measurements were taken with participants standing barefoot, maintaining an upright posture, and recorded to the nearest millimeter. The final values were expressed in centimeters (Malousaris *et al.*, 2008).

Body mass. Body mass was measured using a digital scale (Tefal, range 0–160 kg), and the values were recorded in kilograms (kg) (Malousaris *et al.*, 2008).

Body fat. The thickness of a skinfold, as defined in the Manual of Anthropometric Procedures (Centers for Disease Control and Prevention, 2009) and by Norton & Olds (2001), refers to the layer of subcutaneous fat pinched between two layers of skin at specific anatomical sites. This measurement is typically taken on the right side of the body. It is recorded in millimeters (mm) using a specialized instrument called a skinfold caliper, with the John Bull model (LTD, England) noted for its precision of 0.2 mm. This method provides a reliable and widely accepted means of estimating body fat percentage, a critical factor in health, fitness, and athletic performance assessments (Norton & Olds, 2001; Centers for Disease Control and Prevention, 2009).

Arm span. Arm span was measured as the linear distance between the tips of the middle fingers with both arms fully extended horizontally at shoulder level, parallel to the floor. The subjects stood barefoot, with their back against a wall, and arms outstretched in opposite directions. Measurements were taken using a flexible anthropometric measuring tape and recorded to the nearest millimeter. The final values were expressed in centimeters (Gaurav *et al.*, 2010).

Statistical analysis. All data collected during the research were analyzed using descriptive and comparative statistics. For descriptive statistics, the mean and standard deviation were calculated for each variable. The normality of the distribution of variables was assessed using two methods: skewness and kurtosis. For comparative statistics, a parametric discriminant procedure was employed: one-way analysis of variance (ANOVA) with Bonferroni post hoc tests, which were used to identify differences in anthropometric characteristics. Data processing was carried out using the Statistical Package for the Social Sciences (SPSS) for Windows, version 26.0. Statistical significance was set at $p < 0.05$.

RESULTS

Descriptive parameters of the morphological characteristics of youth athletes in soccer, basketball, and volleyball are presented in Table I.

The analyzed data reveal significant differences in body characteristics among athletes from different sports. The lowest average body height was recorded among soccer players (176.40 ± 7.15 cm), while volleyball players had the highest average height (187.05 ± 6.15 cm), with basketball players positioned in between, averaging 185.15

Table I. Descriptive statistics of the morphological characteristics of youth athletes in soccer, volleyball, and basketball.

Sports (n)	Variables	Mean±SD	Range		Skewness	Kurtosis
			Min	Max		
Soccer (21)	Body Height	176.40 ± 7.15	160.00	191.50	0.50	0.50
Volleyball (9)		187.05 ± 6.15	180.00	196.00	0.71	-1.28
Basketball (16)		185.15 ± 6.34	172.00	196.00	0.56	-0.15
Soccer (21)	Arm Span	177.47 ± 8.35	161.00	192.00	0.50	-0.62
Volleyball (9)		186.50 ± 6.13	175.50	195.00	0.71	-0.24
Basketball (16)		190.00 ± 6.89	175.00	205.00	0.56	1.38

± 6.34 cm. The minimum height observed in soccer players was 160.00 cm, with a maximum of 191.50 cm. Among volleyball and basketball players, the minimum heights were 180.00 cm and 172.00 cm respectively, while the maximums reached 196.00 cm. Skewness coefficients in all groups indicated a slight positive skew in height distribution, without significant deviations, whereas kurtosis values suggested a relatively normal distribution, with slightly more pronounced platykurtosis observed in volleyball players (kurtosis = -1.28).

Regarding arm span, the highest average span was recorded among basketball players (190.00 ± 6.89 cm), followed by volleyball players (186.50 ± 6.13 cm), while soccer players had the lowest average arm span (177.47 ± 8.35 cm). Arm span among soccer players ranged from 161.00 cm to 192.00 cm, among volleyball players from 175.50 cm to 195.00 cm, and among basketball players from 175.00 cm to 205.00 cm. The distribution of arm span was moderately positively skewed in all groups, while kurtosis values indicated a slightly higher concentration around the mean among basketball players (kurtosis = 1.38), whereas the distributions in the other groups were more evenly spread.

In Table II, the mean values and standard deviations for the variables body height and arm span are presented for athletes from three different sports – soccer, volleyball, and basketball. Data analysis revealed statistically significant differences in both variables ($p < .01$), which was also confirmed by the F-test values ($F = 11.551$ for body height and $F = 13.538$ for arm span).

The results presented in Table II and Figure 1 indicate statistically significant differences in body height between soccer players and volleyball players ($p < .001$), as well as between soccer players and basketball players ($p < .001$). Additionally, significant differences were observed in the arm span variable between soccer players and volleyball players ($p < .05$), as well as between soccer players and basketball players ($p < .001$). These differences confirm the existence of pronounced morphological characteristics among athletes from different sports disciplines, which are conditioned by the biomechanical and functional demands of each sport. The greater body height and arm span of volleyball and basketball players compared to soccer players reflect the specific requirements of those sports, where body dimensions play a crucial role in executing jumps, blocks, shots, and ball reception. In contrast, soccer favors low center of mass positions, agility, and speed, where larger body dimensions are not as advantageous to the same extent.

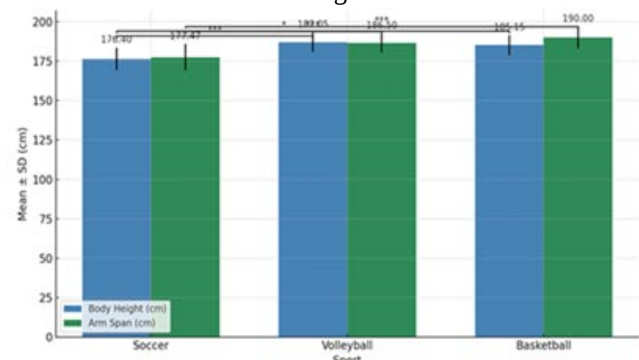


Fig. 1. Comparison of body height and arm span across with statistical significance.

Table II. Morphological differences among young athletes in soccer, volleyball, and basketball.

Sports (n)	Variables	Mean±SD	F	p
Soccer (21)	Body Height	176.40±7.15	11.551	.001
Volleyball (9)		187.05±6.15†***		
Basketball (16)		185.15±6.34‡***		
Soccer (21)	Arm Span	177.47±8.35	13.538	.001
Volleyball (9)		186.50±6.13◇*		
Basketball (16)		190.00±6.89◇***		

* $p < .05$, ** $p < .01$, *** $p < .001$; **Body height:** volleyball-soccer†***; basketball-soccer‡***; **Arm Span:** volleyball-soccer◇*; basketball-soccer◇***

DISCUSSION

The aim of this study was to analyze and compare body height and arm span among youth athletes in soccer, basketball, and volleyball, emphasizing their practical significance in player selection, positioning, and adaptation of the training process. Through a comparative approach, the study seeks to highlight the differences in morphological demands across these sports and the practical application of these insights in working with youth athletes. The findings demonstrate statistically significant inter-sport differences in key anthropometric parameters, thereby supporting the hypothesis that the distinct biomechanical and functional requirements of each sport substantially influence the physical profiles of athletes. Significant differences in stature were observed between soccer players and volleyball players ($p < .001$), as well as between soccer players and basketball players ($p < .001$), while the difference between volleyball and basketball players did not reach statistical significance. A comparable trend was identified for the arm span variable, with soccer players exhibiting significantly shorter arm span values compared to volleyball players ($p < .05$) and basketball players ($p < .001$).

Morphological optimization—defined as the alignment of an athlete's somatic characteristics with the specific demands of a given sport discipline—serves as a foundational principle for long-term talent selection and the individualization of training processes (Toselli *et al.*, 2021). Increased stature and extended arm span confer biomechanical advantages in vertically oriented sports, where actions such as jumping and blocking are predominant. Conversely, shorter and more compact body types facilitate superior center of mass control and agility, which are critical performance factors in sports such as soccer.

The findings of this study are consistent with previous research emphasizing that body height and arm span are key performance advantages in sports such as basketball and volleyball, as they facilitate more efficient execution of vertical actions such as jumping, blocking, and shooting (Carter & Heath, 1990; Gualdi-Russo & Zaccagni, 2001). Basketball and volleyball are classified as vertical sports, characterized by a high frequency of technical actions performed above ground level—such as jump shots, blocks, spikes, ball interceptions, and aerial duels. Consequently, body height and arm span are highly valued morphological characteristics in these disciplines. An extended arm span—often exceeding body height—enhances spatial reach, facilitates easier ball retrieval during jumps, and provides a biomechanical advantage in physical contests (Gaurav *et al.*, 2010; Ziv & Lidor, 2010). Basketball players, particularly those occupying center and power forward positions, typically record the highest values

for these anthropometric parameters, which enhances their effectiveness in shot-blocking and shooting over defenders. Similarly, volleyball players demonstrate elevated values for both stature and arm span, especially those playing as opposites and middle blockers. These characteristics are critical for the successful execution of jump serves, spikes, and blocks, as they enable athletes to operate from greater heights above the net and cover larger spatial zones. In volleyball, the relationship between body height and explosive power (i.e., vertical jump capacity) is especially emphasized, underscoring the importance of an optimal combination of morphological characteristics and functional attributes. In contrast, soccer predominantly prioritizes attributes such as explosive power, agility, endurance, and balance, where extreme anthropometric dimensions may even present a performance constraint (Reilly *et al.*, 2000; Gil *et al.*, 2007). Although body height and arm span are not critical determinants for most field positions, they may play a decisive role in position-specific contexts—most notably among goalkeepers and central defenders. While less frequently investigated in soccer, arm span can influence an athlete's ability to control the ball and react in scenarios involving the use of the upper limbs, such as executing throw-ins from wide areas or reacting to aerial balls. Similar to stature, a greater arm span can enhance effectiveness in ball-blocking and aerial challenges. Moreover, players with a larger reach may have an advantage in shielding the ball and maintaining possession under pressure, as they can better control space and prevent dispossession (Cárdenas-Fernández *et al.*, 2019). Goalkeepers, as the final line of defense, are often selected based on height and limb length, enabling greater spatial coverage and quicker responses when defending shots from varying angles (Malina *et al.*, 2004). Similarly, tall central defenders benefit from superior performance in aerial duels, particularly during set-pieces such as corners and free kicks. Research indicates that taller soccer players often have an advantage in contested aerial situations, which is especially valuable in defensive roles and set-piece execution (Bangsbo & Krstrup, 2008). However, increased stature is frequently associated with greater body mass, which may enhance strength and stability but could also compromise agility—an essential component for rapid movement and directional changes (Reilly & Williams, 2003). Among midfielders and forwards, agility, acceleration, and coordination are typically prioritized performance determinants (Reilly *et al.*, 2000).

Within the training process, understanding athletes' morphological characteristics enables head coaches and strength and conditioning professionals to tailor training content to the individual needs of players. For example, athletes with greater body dimensions require specific approaches to strength development and mobility training in order to maintain movement efficiency and reduce injury risk. Conversely, smaller and lighter athletes typically benefit from targeted

development of explosive power, agility, and coordination. The pronounced inter-sport differences in anthropometric profiles underscore the importance of proper sport orientation during the early stages of athletic development. When physical predispositions—such as above-average height and arm span—are identified at an early age, it becomes possible to guide youth athletes toward the sport that best aligns with their somatic potential, thereby enhancing the likelihood of maximizing their athletic capacity and achieving high-performance outcomes (Carter & Heath, 1990). Beyond initial sport selection, this knowledge is also critical in intra-sport talent identification, particularly in assigning athletes to playing positions that align with their anthropometric profiles. Greater stature during adolescence may signal potential for success in sports such as basketball and volleyball, while arm span is often used as an additional indicator of an athlete's capacity to cover more space on the court or field and to perform position-specific technical actions more effectively (Nikolaidis *et al.*, 2015). Accordingly, systematic monitoring of growth patterns and limb proportions in children and adolescents can play a crucial role in the early identification of sport-specific potential. In the talent selection process, coaches should interpret physical characteristics not merely as static traits, but as dynamic indicators within the broader context of biological maturation, which can reflect long-term athletic potential (Carter & Heath, 1990).

It is important to emphasize that, although body height and arm span are significant contributors to athletic performance, they are not sufficient on their own to predict sporting success. Technical proficiency, tactical game intelligence, psychological competencies, motivation, and consistent engagement in structured training and competition—when combined with favorable morphological characteristics—form the multidimensional foundation for elite athletic achievement (Malina *et al.*, 2004; Ziv & Lidor, 2010). Nevertheless, it is precisely the synergy between innate physical predispositions and well-directed sport-specific practice that often distinguishes an average athlete from a high-performance one.

CONCLUSION

Body height and arm span represent key morphological characteristics that significantly influence talent identification, positional allocation, and the design of training interventions in various team sports. A comparative analysis of soccer, basketball, and volleyball clearly reveals distinct physical demands imposed by each discipline. Basketball and volleyball tend to favor athletes with greater stature and extended reach, while in soccer, these traits are particularly valued in position-specific contexts—most notably among goalkeepers and

central defenders. The application of anthropometric insights in sports practice facilitates more effective talent identification, optimal player positioning within the team structure, and the individualized planning of training loads and content. Understanding the morphological profiles of athletes is a fundamental component of modern athletic development strategies. However, it is essential to recognize that technical-tactical skills and psychological competencies, in conjunction with morphological characteristics, collectively determine athletic success. The integration of anthropometric profiling across all levels of sport and age categories has become a necessity in contemporary sport science, especially within the frameworks of early specialization and talent pathway development.

Scientific and Practical Contribution of the Study

This study provides a significant scientific contribution by identifying sport-specific morphological characteristics among youth athletes across different team sports disciplines. The statistically significant differences observed in body height and arm span between soccer, volleyball, and basketball players enhance our understanding of how somatic traits influence athletic performance and the effectiveness of talent identification processes in sport. A particular value of this research lies in the fact that the data were collected from athletes in their formative developmental stages, offering coaches more accurate guidance in early talent selection and directing children toward sports in which they demonstrate morphological advantages. This supports the concept of morphological optimization—aligning an athlete's physical structure with the specific biomechanical and physiological demands of a given sport—as a key factor in the long-term development of athletic potential. The practical implications of this study are manifold. First, it equips sports scientists and coaches with reliable, easily measurable anthropometric parameters that can improve talent identification and sport orientation in youth populations. Second, it enables more precise player position profiling within team structures, thereby enhancing performance efficiency and on-field synergy. Third, it contributes to the individualization of training programs—taller athletes may present unique biomechanical needs related to balance, mobility, and injury prevention (Nikolaidis *et al.*, 2011), whereas shorter athletes often require training content focused on explosiveness, agility, and neuromuscular coordination. Moreover, understanding inter-sport morphological differences may be beneficial for facilitating athletic transitions between sports (i.e., sport transfer), particularly during adolescence when physical attributes are still developing. These findings are also of practical relevance to sports academies and development centers engaged in systematic monitoring of the growth and maturation of young athletes.

Limitations of the Study and Recommendations for Future Research

Although the study was conducted on a limited sample, the findings provide valuable insights for further understanding of the morphological characteristics of athletes across different sports disciplines. Despite the cross-sectional design of the research and its focus on fundamental anthropometric variables such as body height and arm span, the results clearly indicate the presence of sport-specific morphological patterns. This underscores the importance of systematic anthropometric analysis in the processes of talent identification, player selection, and training orientation. The study sets the foundation for future research that could, through sample expansion, longitudinal methodology, and the inclusion of a broader array of anthropometric and functional parameters, contribute to more refined athlete profiling. Furthermore, integrating position-specific analysis within each sport, along with a multidisciplinary approach that incorporates physiological and psychological domains, represents a logical and valuable direction for advancing scientific knowledge in the field of sports talent development and selection.

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RESUMEN: El objetivo de este estudio fue analizar y comparar la estatura y la envergadura en jóvenes atletas de fútbol, baloncesto y voleibol, destacando su importancia práctica en la selección de jugadores, el posicionamiento y la adaptación al proceso de entrenamiento. La muestra estuvo compuesta por 46 jóvenes atletas de élite divididos en tres grupos: futbolistas ($n = 21$), voleibolistas ($n = 9$) y baloncestistas ($n = 16$). Las mediciones antropométricas se obtuvieron mediante protocolos estandarizados ISAK y se analizaron mediante ANOVA con la prueba post hoc de Bonferroni. Los resultados indicaron diferencias estadísticamente significativas en la altura y la envergadura entre los jugadores de fútbol y los atletas de los otros dos grupos ($p < 0,001$). Los jugadores de voleibol y baloncesto fueron significativamente más altos y tenían mayor envergadura que los jugadores de fútbol. Estas diferencias reflejan las exigencias morfológicas específicas de cada deporte: los deportes verticales como el baloncesto y el voleibol favorecen una mayor altura y alcance, mientras que el fútbol enfatiza la agilidad y un centro de gravedad más bajo. Los hallazgos resaltan la importancia de incorporar el perfil antropométrico en la identificación temprana de talentos y la planificación individualizada del entrenamiento. Los entrenadores y profesionales de la fuerza y el acondicionamiento pueden utilizar estos datos para optimizar el desarrollo de los jugadores y mejorar los criterios de selección. Además, comprender estas distinciones morfológicas puede ayudar a orientar a los jóvenes atletas hacia deportes que mejor se adapten a sus atributos físicos. Esta investigación contribuye a la creciente evidencia que respalda la relevancia del perfil morfológico específico de cada deporte como base para el éxito deportivo a largo plazo.

PALABRAS CLAVE: Características morfológicas; Identificación de talentos; Crecimiento y desarrollo; Rendimiento físico; Deportes de equipo.

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