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ANALYZING AND COMPARING ANTHROPOMETRIC INDICES AS CONTRIBUTORY FACTORS OF INFLUENCE IN SPORTS PERFORMANCE

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Abstract: Sports anthropometry techniques and procedures have been developed over numerous studies and applied in research related to physical or biological anthropology. The purpose of our study was to provide some individual reference anthropometric values in terms of body height and weight, age, the highest points reached by the use of both hands in attack and block actions. The provided data will give us a general overview of the players' anthropometric characteristics regarding their court position. Furthermore, the team position specialization also requires some other biomechanical and dynamic indices of female volleyball players. Values found for height, body weight, and body mass index (BMI) showed similar trends and different characteristics depending on each player's specialization. Our research was conducted in the "Anton Pongratz" Sports Hall within the University of Medicine, Pharmacy, Science, and Technology (UMFST) of Târgu Mureş, for the applied part, and the Department of Human Movement Sciences, for the part of the theoretical foundation of our study. We had a sample group of 12 subjects, all high-performance sports players from the National University Centre of Excellence in Volleyball (NUCEV) – for female teams as an institutional part of the University Sports Club (USC) of UMFST Târgu Mureş. We reported the results of our subjects to a large sample, including 1459 female players who have participated in seven editions of World Championship and Olympic Games between 2000 and 2012. Players' data information was obtained from several different competition databases posted on the International Volleyball Federation (FIVB) official website (www.fivb.org) and from more specialized published papers (i.e. ISI or BDI journals) dealing with this topic. As a result of our study, we can emphasize that we have found a positive correlation between Height to Spike reach and block reach ($r = 0.6531$, $p < 0.05$ / $r = 0.6170$, $p < 0.05$), spike reach and block reach ($r = 0.5883$, $r2 = 0.3461$, $p < 0.05$ / $r = 0.6044$, $r2 = 0.3653$, $p < 0.05$) $r = 0.4565$, $r2 = 0.2083$, $p > 0.05$ / $r = 0.4759$, $r2 = 0.1178$, $p > 0.05$).

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Key words: volleyball, bio-motor index, sports performance, BMI.

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INTRODUCTION

Assessing body composition and anthropometric measurements in athletes can help optimize performance in competitions and monitor success in training and are, therefore, of considerable interest to sports professionals (Ackland et al., 2012). Following specialized studies, it can be argued that improving body composition in athletes is associated with improved cardiorespiratory capacity (Hogstrom et al., 2012) and resistance (Granados et al., 2008). Body structure might also be similar to health problems because therapeutic difficulties may result in sportspeople with shallow body mass, extreme mass changes due to dehydration or eating disorders (Wang et al., 2002). As a subdomain in anthropology, anthropometry has as its object the study of the physical dimensions of the human body for their use in anthropological classifications and comparisons and the appropriate measuring techniques (Budescu, 2013). Passing through prepubertal stages is influenced by biological and growth changes and temperament and personality, social influences, and mature expectations (Bagiu, 2007). Underlining the significant influence of genetic predisposition on performance in modern sports, it should be highlighted that the level of knowledge in this field is based, to a significant extent, on some assumptions and not on accurately proven facts. Among other things, it was demonstrated what kind of genes determines the level of performance in the activity branches related to the manifestation of some speed or resistance qualities, and the results of associative research can only provide some relative images of the real role of different genes - candidate (Jones et al., 2002; Myerson et al., 2000). The situation is also complicated because the somatic aspect is most likely determined by a complex combination of a whole group of genes (Rankinen et al., 2001).

Volleyball is an activity distinguished by supreme-high-intensity interval training motor action and a short duration of this kind of action (jumping, attack, and blocking), followed by periods of reduced physical effort. These actions are influenced by anaerobic metabolism's efficiency, having aerobic metabolism that contributes to maintaining physical performance and post-exercise recovery (Hedrick, 2007; Sheppard et al., 2009). Research shows that supreme-performance volleyball sportspeople get much improve physical and anthropometric wellness than volunteer sportspeople (Gabbett et al., 2007). Therefore, volleyball requires a physical ailment at the maximum degree in addition to tactical and technical performance. To maximize the athletes' adaptive responses and performance, volleyball teams implement other physical training models based on field-specific movement, especially during pre-competitive phases. Resistance preparation is acknowledged as an efficient method of developing neuromuscular capacity between the strategies applied, which increases competitive performance. The manipulation of intensity factors through strength preparation (intensity, volume, etc.) and his delivery over time permits improved physical capacities such as durability, maximal strength, and coordination.

According to a protocol commonly used to assess physical capacity in volleyball, the height reached in the vertical jump test reflects the strength of the limbs (Cronin et al., 2005). However, volleyball lacks protocols that take into account specific motor actions that reflect different simultaneous physical skills. The workout volume for the lower part of the body's plyometric indices is typically quantitated as the number of jumps per exercise session. Previous training guidelines for beginners, intermediate, and advanced participants were 80–100, 100–120, and 120–140 jumps per plyometric training session (Potach et al., 2008). However, the more recent recommendations suggest 80–100 jumps per session for beginner adult athletes, up to 200 for high-intensity plyometric exercises for trained adult athletes. Practically, up to 400 low-intensity

plyometric exercises per training session for adult learners are recommended (Chu et al., 2013). As such, the recommendations for plyometric training workload range between 80 and 400 jumps per training session. Currently, no study has evaluated the optimal plyometric training volume. The role of information technology in our lives must not be neglected. Electronic devices are beneficial in nowadays sports performance as many scientific papers prove (Szabo et al., 2019a)

Previous studies examined the effects of training with plyometric exercises in the training program with a volume between 60 and 100 jumps per training session (Ebben et al., 2010) (Petushek et al., 2010). These studies have shown that the regular training program effectively increases the height of the vertical jump, maximum power, and concentric and eccentric speed. While theoretical recommendations suggest plyometric training programs with 200 jumps per training session, programs with a lower volume have proven to be useful for increasing performance (De Villarreal et al., 2009). Plyometric training is practical when it has a prescribed daily volume range that has been periodically reduced from 60 to 100 jumps to 140 jumps per training session (Miller et al., 2006). Theoretical recommendations have proposed a volume of up to 200 jumps, with a high-intensity plyometric exercise per training session (Chu et al., 2013).
Some scientific papers discovered the negative statistical influence of sports on preventing deficiencies (Szabo et al., 2019b).

The Anthropometric indices are the result of mathematical operations that correlate two or more anthropometric or psychometric data. They allow a more complete and complex interpretation of anthropometric data. Calculation of strength indices allows an interpretation of anthropometric data and more precise guidance for training.

MATERIALS AND METHODS

Participants and location of the research

The study conducted by us investigated the referential indices in terms of height, weight, age, spike, and block by volleyball players depending on the court position and performance sports, on a group of 12 subjects, sports performance women who play for the National University Center of Excellence in Volleyball from Târgu Mureș. Our research was conducted at the Anton Pongratz Sports Hall within the George Emil Palade University of Medicine, Pharmacy, Science, and Technology (UMFST) of Târgu Mureș, the practical part, and the Department of Human Movement Sciences, for the part of the bibliographic study. The research period was from 15.04.2017 to 01.07.2017.

Table 1. Anthropometric information of the research subjects.

No.	Subjects initials	Age (years)	Height (m)	Weight (kg)	BMI	Spike (m)	Block (m)
1.	B.A.	20	1.80	58	17.9	2.95	2.86
2.	V.E	19	1.88	71	18.8	3.10	3.02
3.	S.S.	18	1.83	70	19.1	2.85	2.74
4.	L.T	18	1.80	70	19.4	2.90	2.81
5.	C.A.	19	1.84	70	19	2.93	2.84
6.	B.R.	17	1.86	71	19	2.88	2.79
7.	A.C.	19	1.80	67	18.6	2.87	2.80
8.	D.L	19	1.82	61	16.7	2.89	2.79
9.	R.L.	18	1.66	58	17.4	2.65	2.50
10.	I.R.	19	1.86	70	18.8	3.07	2.99
11.	A.C.	17	1.84	70	19	2.90	2.81

12.	M.L	20	1.70	60	17.6	2.63	2.51
	Average	**18.58 ± 0.9962**	**1.808 ± 0.06538**	**66.33 ± 5.382**	**18.44 ± 0.8361**	**2.885 ± 0.1378**	**2.788 ± 0.1556**

Material and research methods

In the first part of the article, we statistically analyzed whether height, weight, and BMI influenced the spiking and blocking efficiency of the components of the National University Centre of Excellence in Volleyball (NUCEV), in order to determine precisely in which of them there is a positive correlation. All these were achieved with the aid of correlation coefficients Pearson R and Spearman R.

In the second part of our study, we analyzed 1459 female players who participated in the volleyball competitions of the 2000 Olympic Games, the 2002 World Championship, the 2004 Olympic Games, the 2006 World Championship, the 2008 Olympic Games, the 2010 World Championship, and the 2012 Olympic Games. Information regarding the players was retrieved from the different championship databases on the FIVB official website (www.fivb.org) and several technical articles concerning this topic (Palao et al. 2014). A descriptive, correlational, and longitudinal design was used. The variables studied were: the position of the player (Setter, Centre, Outside hitter, Opposite hitter, and Libero), team level (the first level: ranked first - fourth, second level: ranked 5–8, or third level: ranked 9th to the last position), body height (m), weight (kg), body mass index, and player age (years). We compared all these results from the average perspective with the volleyball players from Târgu Mureş National University Centre of Excellence in Volleyball (NUCEV).

Gualdi-Russo and Zaccagni (2001) studied the somatometric and anthropometric specific components for female volleyball players (n=244) according to the field's specific positions and the competition level Italian first and second volleyball league. In the 1992–1993 and 1993–1994 volleyball competitive seasons, they found differences between the two leagues' level, first and second, and the player's position on the court. They found similar results for female volleyball players in Greece (n=163). The research also revealed that higher-level players (First league vs. the Second league) were taller and had a lower BMI. The same trend was found for women's volleyball in the first Spanish division compared with the final team ranking (Martín-Matillas et al., 2014; Carvajal et al. 2012) analyzed specific anthropometric and somatometric data in a study of the women's volleyball team from Cuba at three Olympic Games (from 1992 to 2000).

RESULTS

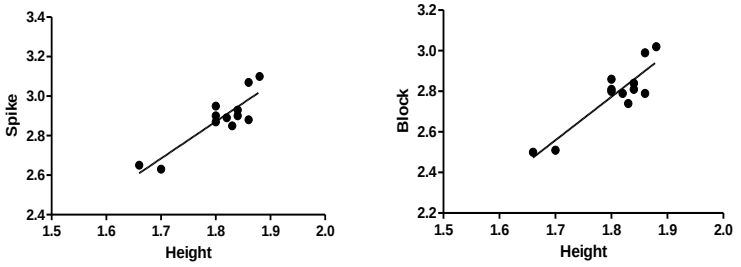
Statistical results

Table 2. Height to spike reach and block reach correlation

Height	**Spike**	**Block**
Number of XY Pairs	12	12
Spearman r	**0.6531**	**0.6170**
95% confidence interval	0.1075 to 0.8964	0.04737 to 0.8838
P value (two-tailed)	**0.0213**	**0.0326**
Is the correlation significant? (alpha=0.05)	Yes	Yes

Correlation coefficient r = 0.6531, positive correlation, a high value of height correlates with a high spike value (a person with higher values in height will have a high value at spike point). The correlation is statistically significant ($p < 0.05$). Correlation coefficient r = 0.6170, positive correlation, a high value of height correlates with a high value of the block point (a person with a

high value of height will have a high value at the block point). The correlation is statistically significant ($p < 0.05$).



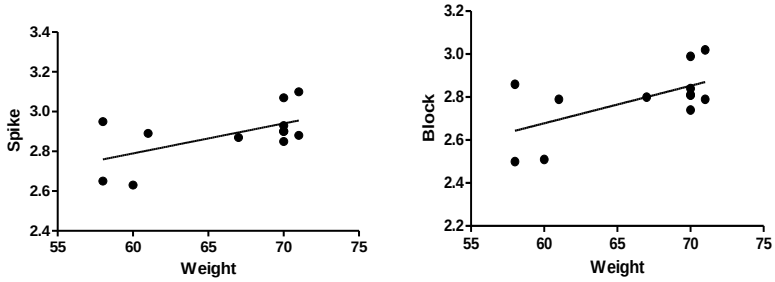
(a) **(b)**

Figure 1. Height to spike reach (a) and height to block reach (b)

Table 3. Weight to spike reach and block reach correlation

Weight	Spike	Block
Number of XY Pairs	12	12
Pearson r	**0.5883**	**0.6044**
95% confidence interval	0.02159 to 0.8689	0.04659 to 0.8749
P value (two-tailed)	**0.0442**	**0.0374**
Is the correlation significant? (alpha=0.05)	Yes	Yes
R squared	**0.3461**	**0.3653**

Correlation coefficient r = 0.5883, positive correlation, a high value of weight correlates with a high value of spike point (a person with a high weight value will have a high value at the spike point). The correlation is statistically significant ($p < 0.05$). Coefficient of determination ($r2 = 0.3461$), 34.61% of the variance between spike values in the studied group is due to weight variations. Correlation coefficient r = 0.6044, positive correlation, high weight value correlates with a high value of the block point (a person with a high weight value will have a high value and block point). The correlation is statistically significant ($p < 0.05$). The determination coefficient ($r2 = 0.3653$), 36.53% of the variation existing between the studied group's block values, is due to variations in weight.



(a) **(b)**

Figure 2. Weight to spike reach (a) and weight to block reach (b)

Table 4. BMI to spike reach and block reach correlation

BMI	Spike	Block
Number of XY Pairs	12	12
Pearson r	**0.4565**	**0.4759**
95% confidence interval	-0.1593 to 0.8165	-0.1350 to 0.8246
P value (two-tailed)	**0.1358**	**0.1178**
Is the correlation significant? (alpha=0.05)	No	No
R squared	**0.2083**	**0.2265**

Correlation coefficient r = 0.4565, positive correlation, a high BMI value correlates with high value at the spike point (a person with a high BMI value will have a high value at the spike point). The correlation is not statistically significant (p> 0.05). The determination coefficient (r2 = 0.2083), 20.83% of the variance between spike values in the studied group, is due to their BMI variation. Correlation coefficient r = 0.4759, positive correlation, a high BMI value correlates with high value at the block point (a person with a high BMI value will have a high value at the block point). The correlation is not statistically significant (p> 0.05). The coefficient of determination (r2 = 0.2265), 22.65% of the variation between the studied group's block values, is due to their BMI variation.

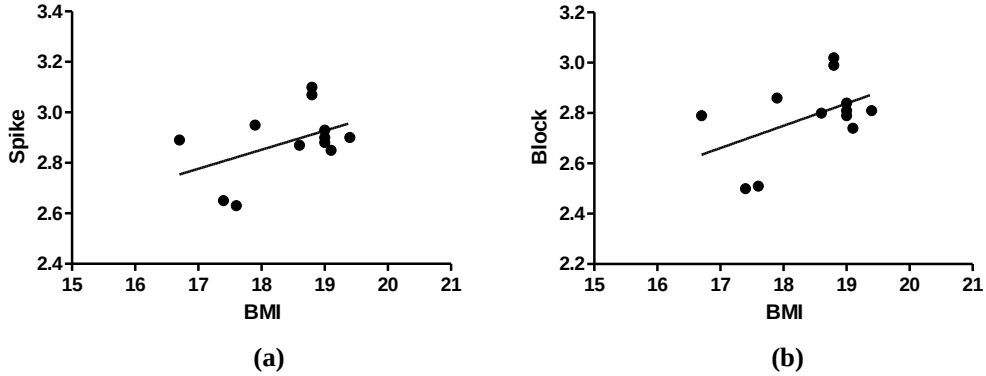


Figure 3. BMI to spike reach (a) and BMI to block reach (b)

Centralization of anthropometric data

Table No. 5 presents the average of the height of the players in the seven final tournaments that we analyzed, the weight, the body mass index, the spike reach, the block reach, and the comparison of the world's elite average compared with the National University Centre of Excellence in Volleyball (NUCEV). The table also includes the height of the player, Weight, BMI, maximum spike reach point, maximum block reach point, and the age of volleyball players who participated in the OG and WC between 2000 and 2012, compared with NUCEV from Târgu Mures.

Table 5. The anthropometric data of players who participate in the last seven essential competitions

Competition	Height (m)	Weight (kg)	BMI	Spike (m)	Block (m)	Age (years)
2000 OG	1.82	71.7	21.8	3.05	2.90	25.3
2002 WC	1.82	70.4	21.3	3.01	2.88	24.8
2004 OG	1.82	71.6	21.5	3.03	2.91	26.1
2006 WC	1.82	69.9	21.1	3.00	2.88	24.8
2008 OG	1.83	70.1	20.9	3.03	2.91	25.6
2010 WC	1.83	69.8	20.9	3.00	2.88	27.1

2012 OG	1.82	69.5	20.9	3.01	2.88	26.2
Average (A_1)	**1.82**	**70.3**	**21.2**	**3.01**	**2.89**	**25.7**
Average (A_2)	**1.80**	**663**	**18.4**	**2.88**	**2.78**	**17**
Δ (A_1-A_2)	**0.02**	**4**	**2.8**	**0.13**	**0.11**	**8.7**

Legend: A_1 – the average of the players present at the seven major volleyball competitions
A_2 – the average of the NUCEV players

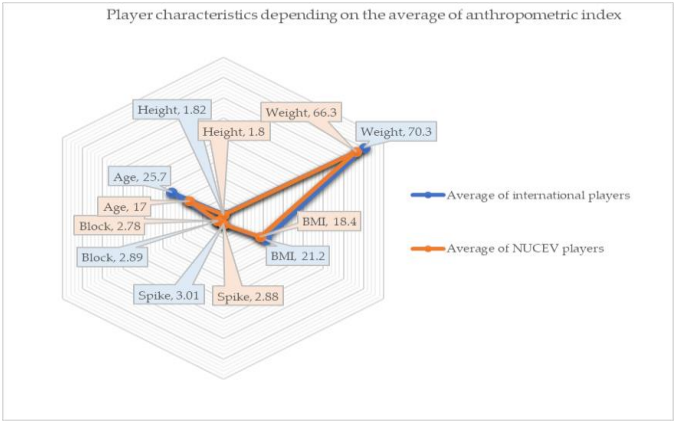


Figure 4. Player characteristics depending on the average of the anthropometric index

Comparison of the height index

From the teams participating in the final tournaments. In terms of height (Table no. 6), the tallest players were the centers, followed by the opposite hitters, outside hitters, setters, and Libero. There were no significant differences between the center and opposite hitter players. Teams that finished the competition between 1–4th places had the tallest players for all positions on the court.

Table 6. Characteristics of players depending on the place on the court and height

Place on the competition	**Place on court**					**Average (m)**
	Setter (m)	**Centre (m)**	**Outside hitter (m)**	**Opposite hitter (m)**	**Libero (m)**	
1–4	1.77	1.88	1.86	1.89	1.72	1.84
5–8	1.77	1.87	1.84	1.86	1.71	1.83
9–12	1.78	1.85	1.83	1.83	1.71	1.81
Average A_1	**1.77**	**1.86**	**1.84**	**1.85**	**1.71**	**1.82**
Average A_2	**1.80**	**1.85**	**1.83**	**1.83**	**1.68**	**1.80**
Δ (A_1-A_2)	**-0.03**	**0.01**	**0.01**	**0.02**	**0.03**	**0.02**

Comparison of National University Centre of Excellence in Volleyball (NUCEV) from Târgu Mureș/post results with those of the teams participating in the seven final tournaments, depending on the place in the ranking. As for the average height of the setters, at the NUCEV the average height was 1.80 m that was above all other averages. For the center players, the NUCEV average height was 1.85 m that was below the average of the participating teams but identical to teams ranked 9–12;

The outside hitter players were at the middle of the teams 9–12 ranking and below the average of the other top-ranked teams. The opposite hitters had a 1.68 m height average that was below the average of all ranked teams. With 1.68 m, the Libero players were under all the teams of the world elite. As a general average of 1.80 m height, the NUCEV players were below all teams' average.

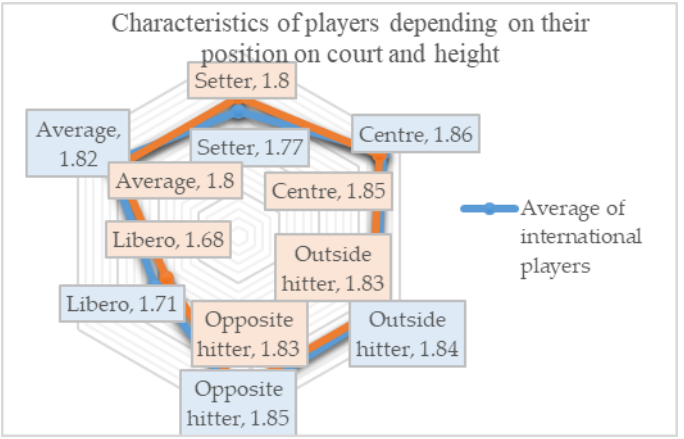


Figure 5. Characteristics of players depending on their position on court and height

Comparison of weight index

From the teams participating in the final tournaments:

Athletes with the highest average weight index were the center players, followed by outside hitters, opposite hitters, setters, and Libero. In the correlation of the weight index with the place in the ranking, the higher the place, the higher the weight index (a difference of 2–3 kg was observed).

Table 7. Characteristics of players depending on their position on court – Weight

Place in competition	Place on court					Average (kg)
	Setter (kg)	Centre (kg)	Outside hitter (kg)	Opposite hitter (kg)	Libero (kg)	
1–4	67.9	74.4	73.4	73.3	64.4	71.8
5–8	67.8	73.4	71.0	71.3	62.3	70.3
9–12	67.2	72.0	71.5	69.7	63.5	69.7
Average A_1	**67.5**	**72.9**	**71.8**	**70.9**	**63.4**	**70.3**
Average A_2	**58**	**70**	**67**	**70**	**59**	**64.8**
Δ (A_1-A_2)	**9.5**	**2.9**	**4.8**	**0.9**	**4.4**	**5.5**

Comparison of NUCEV/post results with those of the teams participating in the 7 final tournaments, depending on the place in the ranking and their average weight. As the average weight of the setter players, at the NUCEV the average was 58 kg, and it was under all the index of the participating teams. For center players, the NUCEV average weight was 70 kg, and it was below the average of the participating teams, comparing only with the teams ranked 9–12. The outside hitters' average weight was below the average of the other teams, namely 67 kg. The opposite hitters' having a 70 kg weight average were above the average of teams ranked 9–12, 69.7 kg, and below their overall average of 70.9. With an average weight of 59kg, the libero players were under all the teams of the world elite. As a general average of the weight index, 64.8 kg, the NUCEV players were below all teams' average.

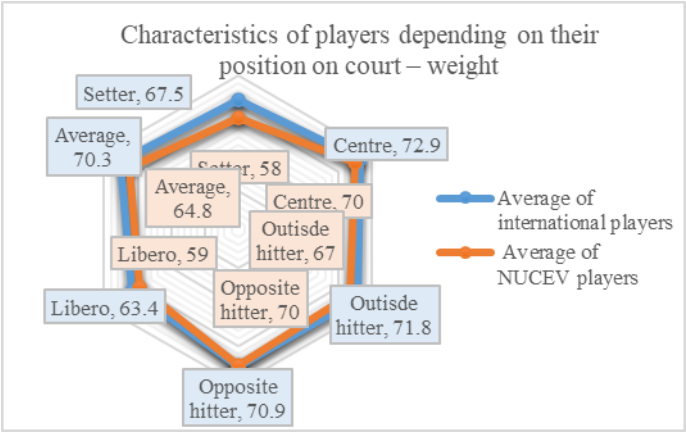


Figure 6. Characteristics of players depending on their position on court – Weight

Comparison of body mass index (BMI)

From the teams participating in the final tournaments.Values for BMI showed the same trends as body height and weight (Table 8). Opposite hitters had a lower BMI than the other players: setters, outside hitters, and Libero. Also, significant differences between centers and Libero were found. For all player positions, NUCEV BMIs were significantly lower than top BMIs.

Table 8. Characteristic of players depending on their position on court and BMI

Place in the competition	Position on court					Average
	Setter	Centre	Outside hitter	Opposite hitter	Libero	
1–4	21.6	21.0	21.3	20.7	21.8	21.2
5–8	21.6	20.1	21.1	20.7	21.2	21.1
9–12	21.4	21.0	21.	20.7	21.7	21.2
Average A_1	**21.5**	**21.0**	**21.3**	**20.7**	**21.6**	**21.2**
Average A_2	**17.9**	**18.9**	**18.3**	**19.1**	**17.5**	**18.3**
Δ (A_1-A_2)	**3.6**	**2.1**	**3**	**1.6**	**4.1**	**2.9**

Comparison of NUCEV/post results with those of the teams participating in the seven final tournaments, depending on the place in the ranking. As the average of the setter players, the NUCEV average was 17.9 points, an average that is below all the scores of the participating teams. For center players, the NUCEV average was 18.9 points and was below the average of all participating teams. The outside players were below the average of the other teams, with a BMI of 18.3 points. The opposite hitters had a 19.1 average BMI and were above the average of all teams in the ranking. With 17.5 points, the libero players were under all the world teams. The general average BMI of NUCEV players was 18.3 points below the average of all teams.

The maximum point of the spike (MPS)

From the teams participating in the final tournaments. Regarding the spike's maximum point (Table 9), the players who had the highest indices were centers and opposite hitters, followed by outside hitters, setters, and Libero. From the world elite teams, the higher the ranking, the higher the MPS index.

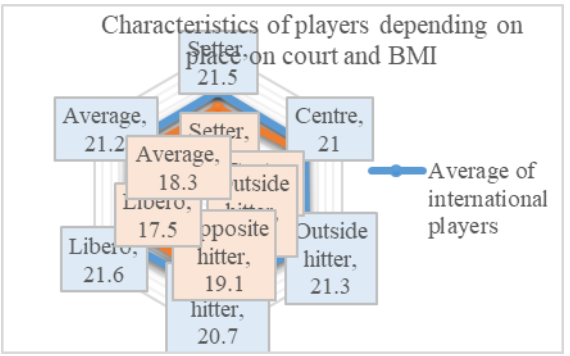


Figure 7. Characteristics of players depending on the place on the court and BMI

Table 9. Characteristics of players depending on the place on court and spike

Place in the competition	Place on court					Average (m)
	Setter (m)	Centre (m)	Outside hitter (m)	Opposite hitter (m)	Libero (m)	
1–4	2.96	3.12	3.09	3.12	2.88	3.06
5–8	2.98	3.12	3.09	3.08	2.85	3.05
9–12	2.90	3.03	3.01	3.02	2.80	2.98
Average A_1	**2.94**	**3.07**	**3.05**	**3.07**	**2.82**	**3.01**
Average A_2	**2.95**	**2.98**	**2.89**	**2.95**	**2.64**	**2.88**
Δ (A_1-A_2)	**-0.01**	**0.09**	**0.16**	**0.12**	**0.18**	**0.13**

Comparing the NUCEV/post results with those of the teams participating in the seven final tournaments, depending on the place in the ranking. As the average of the setters, the NUCEV players' average was 2.95 m that was above the average of the teams ranked 9–12. For center players, the NUCEV players' average was 2.98 m and was below the average of the participating teams. The outside hitter players were below the average of the other teams, 2.98 m. The opposite hitters had an average of 2.89 m and were under the average of all teams. With a 2.64 m average, the libero players were under all the teams of the world elite. As the general average of the maximum spike point reached was 2.88 m, the NUCEV players were below all teams' average.

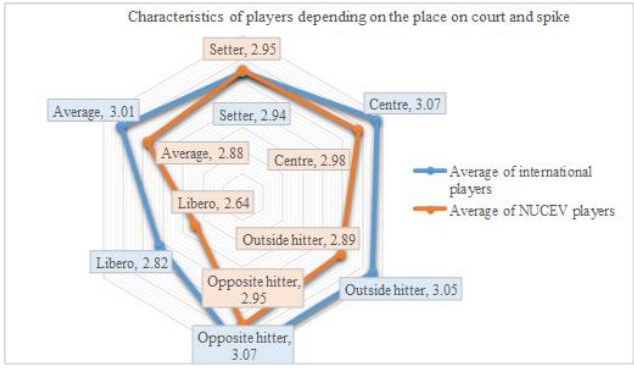


Figure 8. Characteristics of players depending on the place on court and spike

The comparison between the maximum block points (MBP) from the teams participating in the final tournaments. Regarding the maximum block point reached (Table 10), we noticed that the highest index players reached block points were centers and opposite hitters, followed by outside

hitters, setters, and Libero. From the volleyball elite, the MBP average rises gradually from teams 9–12 to teams 1–4.

Table 10. Characteristics of players depending on the place on court and block

Place in the competition	Place on court					Average (m)
	Setter (m)	Centre (m)	Outside hitter (m)	Opposite hitter (m)	Libero (m)	
1–4	2.84	2.99	2.96	2.98	2.76	2.93
5–8	2.87	2.99	2.95	2.96	2.74	2.93
9–12	2.79	2.91	2.89	2.90	2.69	2.86
Average A_1	**2.82**	**2.95**	**2.92**	**2.93**	**2.71**	**2.89**
Average A_2	**2.86**	**2.90**	**2.80**	**2.85**	**2.50**	**2.88**
Δ (A_1-A_2)	**-0.04**	**0.05**	**0.12**	**0.08**	**0.21**	**0.01**

Comparison between NUCEV/post results with those of the teams participating in the seven final tournaments, depending on the place in the ranking. As the average of the setter players, the NUCEV average was 2.86 m, which was above the average of the teams ranked 1–4 and 9–12. For center players, the NUCEV average was 2.90 m, which was below the average of the participating teams. The outside players were below the average of the other teams, 2.80 m. The opposite players had an average of 2.85 m and were under the average of all teams. At 2.50 m, the libero players were under the average of the teams in the world elite.As a general MBP average was 2.88 m, the NUCEV players were below all teams' average.

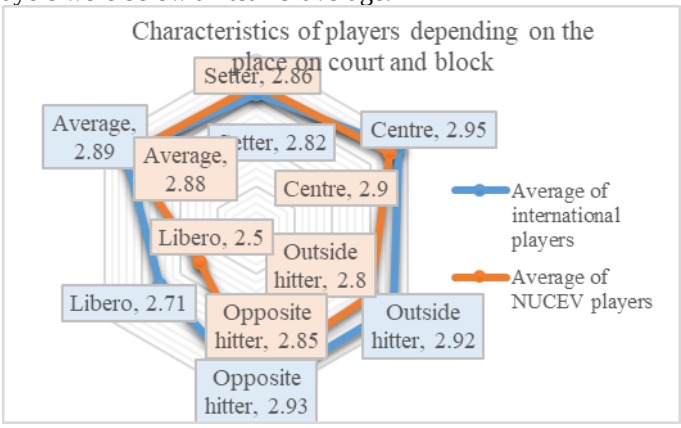


Figure 9. Characteristics of players depending on the place on court and block

Comparison of age index

From the teams participating in the final tournaments. In terms of age (Table 11), at the level of performance, the average age of players from the 1–4th place was significantly higher than at the 5–12 place players for setters, centers, outside hitters, and Libero. The only exception was the opposite hitter players, who were older in the 5–12 place teams.

Table 11. Characteristics of players depending on the place on court and age

Place in the competition	Place on court					Average (years)
	Setter (years)	Centre (years)	Outside hitter (years)	Opposite hitter (years)	Libero (years)	

1–4	27.0	26.0	26.2	25.4	28.0	26.3
5–8	25.8	25.7	25.9	25.9	26.6	25.9
9–12	25.4	24.6	25.5	25.6	25.5	25.3
Average A_1	**25.9**	**25.2**	**25.7**	**25.6**	**26.2**	**25.7**
Average A_2	**20**	**18**	**18.5**	**18.3**	**19**	**18.7**
Δ (A_1-A_2)	**5.9**	**7.2**	**7.2**	**7.3**	**7.2**	**7**

Comparison of NUCEV/post results with those of the teams participating in the seven final tournaments, depending on the place in the ranking. As the average age of the setters, the NUCEV average was 20 years old, below the average of the teams participating in the final tournaments. For center players, the average age of NUCEV was 18 years old that is below the average of the participating teams. Outside hitters were under the average of the other teams, 18.5 years old. The opposite hitters had an average of 18.3 years old and were below the average of teams ranked 9–12, who was 25.6 years old. As a general average of the age index, 18.7 years, the NUCEV players were below all teams' average.

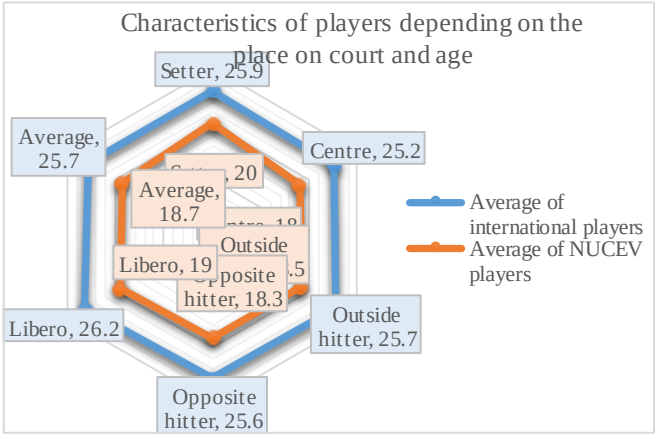


Figure 10. Characteristics of players depending on the place on court and age

DISCUSSIONS

As a first result, with respect to the correlation of the anthropometric indices of NUCEV, we can state that we found a positive correlation between Height to Spike reach and block reach (r = 0.6531, p <0.05 / r = 0.6170, p <0.05) Spike reach and block reach (r = 0.5883, r2 = 0.3461, p <0.05 / r = 0.6044, r2 = 0.3653, p <0.05) r = 0.4565, r2 = 0.2083, p> 0.05 / r = 0.4759, r2 = 0.1178, p> 0.05).

After this investigation, we can claim that the center volleyball players, the opposite volleyball players, and the outside hitter volleyball players are taller, more massive, and have better indices at the highest point reach of spike and block. These results confirm previous studies regarding the indices we investigated in this paper (Palao et al., 2014; Gualdi-Russo et al., 2001; Malousaris et al., 2008). The data provided in this research is generally because the primary purpose of this inquiry is to provide reference values. As far as performance is concerned, the best teams have centers, opposite hitters, and outside taller hitters with a higher weight index.

More precisely, the best teams ranked 1–4 in the final tournaments and have much better strength indices. This could be one reason for these teams' sports performance, as spike and block are the most meaningful actions in winning a point in the volleyball game (Palao et al., 2014; Palao et al., 2004; Palao et al., 2009). As for the average age, similar values were found between

the ranking positions of the teams. Differences between centers and Libero between teams ranked 1–4 and 9–12 place could indicate the importance of age indices, as for the 1–4 rank team players with the most experience in spiking and blocking.

These findings confirm previous studies that focused on developing the biometric qualities of volleyball players (Palao et al., 2014; Gualdi-Russo et al., 2001). The higher the ranking of the team, the higher the bio-motricity of their players. The data show that the level of teams participating in the Olympic Games and the World Championship, the physical and motor characteristics are of significant importance for the team's success in women's volleyball (Palao et al., 2014).

This study provides reference values to guide player selection, understand the game dynamics, and understand a team's role based on the position on the court. The players' characteristics result from the selection process (natural and intentional) and the specific training in the sports training specific to this game. Information about players who have participated in final significant tournaments can be used as reference criteria in volleyball's multifactorial talent selection process. From a general perspective, the results indirectly show that long-term specialized training is required after technical training. The acquisition of competition experience of a minimum duration of 10–12 years is necessary to achieve peak performance, in addition to the importance of bio-motor factors (Palao et al., 2014).

CONCLUSIONS

The model of the determinants of sports performance in the endless selection of the volleyball game, the anthropometric indices will find their usefulness at the selection level and the specialized sports practice. The results show the differences between body height, maximum blocking point, maximum spike point, and players' age depending on the court's position. These differences are related to the needs of the various specific posts in terms of the actions that take place there.

Centers, opposite hitters, and outside hitters have favorable abilities to block and spike, and the setters and Libero have abilities that can be more suited for the second line, receiving the ball and defense. The anthropometric and force indices that differentiate the first teams at this level by teams ranked lower. The athletes' physical characteristics have a tremendous influence on the performance level, which has been dealt with in many research papers, revealing that the height index can play a significant role in contributing to some sports' success, offering some natural advantages. Due to the results of descriptive investigations, a new demand has emerged in sport anthropometric research, and the focus of new investigations has become analysis - the relationship between anthropometric and motor characteristics.

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