POSITIONAL DIFFERENCES IN BODY COMPOSITION AND JUMPING PERFORMANCE AMONG YOUTH ELITE VOLLEYBALL PLAYERS

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Abstract
The aim of this study was to examine the positional differences in body composition and jumping performance of elite youth volleyball players. The research was conducted on a youth national team players of Serbia (n=28, average age=15.68±0.47 years). Players were categorized as middle blockers (n = 7), opposite hitters (n = 5), outside hitters (n = 8), setters (n = 6), and liberos (n = 2). The middle blockers and the opposite hitters are the tallest (201.57±4.92 cm; 203.00±4.41 cm) and the heaviest (86.14±6.79 kg; 91.60±6.69 kg) players in the team. The smallest values for body height and body weight was found among liberos. The results of % body fat have shown the smallest values among liberos (11.60±3.06) and the greatest among the opposite hitters (14.00±1.64). The results in jumping performance tests have shown similar values for all the positions in the team with no statistically significant difference. Statistically significant difference was found among positions for body height, body weight and standing reach height. It can not be concluded that volleyball players develop distinctive performance characteristics at this age and level. Therefore, more researches must be conducted in order to understand better selection and training process that consider positional roles and demands.

Key words*: anthropometric, jumping, spike, block, body mass index*

Introduction

The popularity of volleyball has grown in the past two decades and the game continues to build momentum at all competitive levels (Scates and Linn, 2003). Volleyball is an intermittent sport that requires players to compete in frequent short bouts of high-intensity exercise, followed by periods of low-intensity activity (Kunstlinger et al., 1987; Viitasalo et al., 1987; Gabbett and Georgieff, 2007). During these high-intensity bouts of activity, players are involved in defensive and offensive jumping activities (Dyba, 1982; Polgaze and Dawson, 1992). These jumping activities can include both horizontal approach movements (spike jumps, SPJ) and movements without an approach (jump setting, jousts, blocking) (Sheppard et al., 2008). Nowadays, elite volleyball players are quicker, stronger and in better physical condition than before which could be a result of year-round training and developing skills that add strength, power and fitness specific to their sport (Scates and Linn, 2003). A volleyball squad comprises 12 players with team positions broadly defined as setters, hitters (outside hitter/left side hitter and opposite hitter/right side hitter), middle blockers, and liberos. Each of these positions plays a specific role in a volleyball match (Gabbett and Georgieff, 2006). Considering the specialized role of the various positions in volleyball and the specific tasks involved, it is likely that differences exist in the physiologic characteristics among the playing positions, but this is not well understood (Sheppard et al., 2009). Before the rule changes, positional roles were not so obvious and there were many universal players that could play different roles. High-level competition demands and evolving tactical play strategies have led to an increase in the specialization of player positions (Sheppard et al., 2009). Several studies have compared the anthropometric and physiological profiles of volleyball players according to their playing positions (Gualdi-Russo and Zaccagni, 2001; Duncan et al., 2006; Malousaris et al., 2008). However, to the authors' knowledge no similar studies that compare body composition and jumping performance in elite youth volleyball players are available. There are a lot of body composition components in sports but the most important component in all sports is body fat. In sport and in high-performance sport in particular, the continuous monitoring of body composition may regulate load in the training process and positively affect top form. Body composition is therefore considered as one of the components of physical fitness of athletes (Mala et al., 2010). An understanding of the morphological and physical profile of youth elite volleyball players may be important for talent identification and physical qualities important for specific positions in the team. Therefore, the aim of this study was to examine the positional differences in body composition and jumping performance of elite youth volleyball players.

Methods

Subjects
The screen sample was composed of the best volleyball players (youth national team - U16) of Serbia (N=28, average age=15.68±0.47 years).

All participants were members of the national team nominated by the Serbian Volleyball Federation for the calendar year of 2009 and 2010. Players were categorized according to playing position and role. Players were categorized as middle blockers (n = 7), opposite hitters (n = 5), outside hitters (n = 8), setters (n = 6), and liberos (n = 2). All subjects received a clear explanation of the study, including the risks and benefits of participation, and written parental or guardian consent was obtained before players were permitted to participate. The protocol of the study was approved by the Ethical Committee of the Faculty of Sport and Physical Education, University of Nis, according to the revised Declaration of Helsinki. In addition, they completed a health history questionnaire and were informed that they could withdraw from the study at any time.

Testing protocols

In the 24-hour period before performing the tests, the subjects refrained from activity that was considered unduly fatiguing in regard to vertical jump. Subjects were given up to 3 trials on each jump, with 1 minute rest between jump test trials. The subjects were all tested during the season. The subjects completed their typical practice warm-up before testing sessions. This warm-up included 10 minutes of general activity (walk, jog, light stretching), followed by 10 minutes of dynamic activity that increased in speed and intensity, 10 minutes of 2-person volleyball skill rally, followed by 3 to 5 minutes of rest before beginning the testing session.

Procedures

Body height and body weight were measured according to the instructions of the International Biological Program–IBP (Weiner and Lourie, 1969). The body height was measured with a GPM anthropometer (Siber & Hegner, Zurich, Switzerland) to the nearest 0.1cm. Body weight was obtained by TANITA BC 540 (TANITA Corp., Arlington Heights, IL) to the nearest 0.1kg. Body mass index (BMI) was calculated by formula: BMI=body weight (kg) / (body height (m))^2. Percentage of body fat (Bfat%) was calculated with an age-specific formula: Child Body Fat % = (1.51 x BMI) - (0.70 x Age) - (3.6 x gender) + 1.4 (Weststrate and Deurenberg, 1989; Deurenberg et al. 1990). For the standing reach, while wearing their normal volleyball footwear, the subjects stood underneath the vanes of the apparatus and were encouraged to fully extend their dominant arm to displace the highest vane possible to determine their maximum standing reach height. The measurement of the standing reach height allowed for a calculation of the relative jump heights on each of the jumping tasks (absolute jump height [cm] – standing reach height [cm] = relative jump height) (Sheppard et al., 2009). Lower-body muscular power was estimated by the vertical jump test (VJ), the spike jump test (SJ) and the standing broad jump (SBJ). Jump and reach performance was measured using a Vertec (Questtek Corp., Northridge, CA).

Reach height was established by having the subject stand flat-footed and reach up to displace the marker on the Vertec. The subject then performed two types of jumps: a) the standing vertical jump and reach (VJ) for which he dipped to a self-selected depth and then jumped and reached with two hands to displace the marker on the Vertec. b) a three-step approach followed by a takeoff from one leg to reach and displace the marker on the Vertec (SJ). Three trials were permitted for all jumps with the highest jump being used in subsequent statistical analysis. Vertical jump height and spike jump height was measured to the nearest 1 cm. A standing broad jump (SBJ) was also utilized to measure leg power. The distance was measured to the nearest 1 cm. Three jumps were performed and the best jump has been used for statistical analysis.

Statistical analysis

The statistical Package for Social Studies SPSS (v17.0., SPSS Inc., Chicago, IL) was used for statistical analysis. Descriptive statistics were reported as mean±SD for all measures with special analysis for positions in team. A one-way analysis of variance was used to determine significant differences among positions in body composition and jumping characteristics. The level of significance was set at $p \leq 0.05$.

Results

Table 1 shows anthropometric characteristics of players according to their position in the team. The middle blockers and the opposite hitters are the tallest (201.57±4.92 cm; 203.00±4.41 cm) and the heaviest (86.14±6.79 kg; 91.60±6.69 kg) players in the team. The smallest values for body height and body weight was found among liberos (181.50±4.94 cm; 66.50±12.02 kg). Values for BMI are similar for all positions and ranges from 20.10 to 22.21, while the results of body fat% have shown the smallest values among liberos (11.60±3.06%) and the greatest among the opposite hitters (14.00±1.64%).

Table 1 Body composition and standing reach height of the subjects. Data are means ± SD

	N	Body height (cm)	Body weight (kg)	BMI (kg/m^2)	Body Fat (%)	Standing reach height (cm)
Outside hitters	8	195.25 ±3.10	82.50 ±5.18	21.50 ±1.13	13.19 ±1.38	249.75 ±4.77
Middle blockers	7	201.57 ±4.92	86.14 ±6.79	21.36 ±2.14	13.08 ±2.60	259.71 ±6.21
Setters	6	194.33 ±6.18	81.66 ±8.54	21.60 ±1.94	13.29 ±2.37	251.00 ±8.60
Liberos	2	181.50 ±4.94	66.50 ±12.02	20.10 ±2.55	11.60 ±3.06	234.00 ±8.48
Opposite hitters	5	203.00 ±4.41	91.60 ±6.69	22.21 ±1.35	14.00 ±1.64	260.00 ±7.64
Total	28	197.03 ±7.15	83.71 ±8.89	21.51 ±1.68	13.22 ±2.03	253.21 ±9.53
BMI-body mass index						

The results in VJ and SJ test shows similar values for all the positions in the team (Table 2). The liberos have shown slightly greater results in these tests (VJ = 63.5±9.2 cm; SJ = 77.0±7.1 cm). In the SBJ test opposite hitters have had the smallest values (233.2±42.6 cm) and the liberos had the greatest (272.0±28.3 cm), while the values for the other positions in the team were similar and have ranged from 251.0 to 253,0 cm (Table 2).

Table 2. Jumping performance of the subjects. Data are means ± SD

	N	VJ (cm)	SJ (cm)	SBJ (cm)
Outside hitters	8	53.2 ±5.5	67.7 ±6.7	252.0 ±15.8
Middle blockers	7	51.4 ±4.3	64.4 ±5.9	253.8 ±7.9
Setters	6	52.8 ±7.8	66.0 ±10.1	251.0 ±19.6
Liberos	2	63.5 ±9.2	77.0 ±7.1	272.0 ±28.3
Opposite hitters	5	53.8 ±10.0	68.6 ±9.3	233.2 ±42.6
Total	28	53.5 ±7.1	67.3 ±7.9	250.3 ±23.3
VJ-vertical jump, SJ- spike jump, SBJ- standing broad jump				

A one way Anova shows statistically significant difference for body height, body weight and standing reach height, while there were no difference in any other tested variables (Table 3).

Discussion

Our aim was to examine the positional differences in body composition and jumping performance of elite youth volleyball players. Several studies exist on positional differences in volleyball but according to authors knowledge there were no such studies among elite youth volleyball players that analyze body composition and jumping performance. If significant differences exist, it could be important for training program designs and talent identification for different positions in the team. Our results revealed significant differences in some variables of body composition, but there were no significant differences in the jumping performance among individual playing positions. The results have shown that the middle blockers and opposite hitters were the tallest and the heaviest players in the team, whereas the libero players were the smallest and the lightest (Table 1), which was in similarity with results found among professional volleyball players (Marques et al., 2009). Given the fact that the middle blockers and opposite hitters were taller , the difference in the standing reach height was obvious (Table 1). In addition, recent researches on elite male players indicate a trend toward an increase in height and significant differences in height and body mass among positions (Marques et al., 2009). In volleyball, this differences could be the result of different technical and tactical demands placed on players in different positions (Duncan et al., 2005).

Table 3. Difference among positions in the tested variables. Data are means ± SD

	Outside hitters	Middle blockers	Setters	Liberos	Opposite hitters	Anova *p*
Body Height (cm)	195.25 ±3.10	201.57 ±4.92	194.33 ±6.18	181.50 ±4.94	203.00 ±4.41	**0.000**
Body Weight (kg)	82.50 ±5.18	86.14 ±6.79	81.66 ±8.54	66.50 ±12.02	91.60 ±6.69	**0.005**
BMI (kg/m^2)	21.50 ±1.13	21.50 ±1.13	21.50 ±1.13	20.10 ±2.55	22.21 ±1.35	0.700
Body Fat (%)	13.19 ±1.38	13.08 ±2.60	13.29 ±2.37	11.60 ±3.06	14.00 ±1.64	0.754
Standing reach Height (cm)	249.75 ±4.77	249.75 ±4.77	251.00 ±8.60	234.00 ±8.48	260.00 ±7.64	**0.005**
VJ (cm)	53.20 ±5.5	51.40 ±4.3	52.80 ±7.8	63.50 ±9.2	53.80 ±10.0	0.339
SJ (cm)	67.70 ±6.7	64.40 ±5.9	66.00 ±10.1	77.00 ±7.1	68.60 ±9.3	0.398
SBJ (cm)	252.00 ±15.8	253.80 ±7.9	251.00 ±19.6	272.00 ±28.28	233.20 ±42.6	0.339
BMI-body mass index, VJ-vertical jump, SJ- spike jump, SBJ- standing broad jump						

In contrast to increasing height trend in volleyball, some coaches and sport scientist believe that taller and heavier athletes, like those selected to be middle blockers, are inherently slower at rapid movements (Sheppard and Borgeaud, 2008). Nevertheless, Sheppard et al. (2009) concluded that according to the demands of elite match conditions and the physiologic characteristics of elite players, volleyball coaches and sport scientists should aim to select taller athletes with well development speed characteristics. Thus, capability to move fast laterally at the net should be considered as very important. Generally, low body fat is very important for high physical performance in sport. In addition, Fleck et al. (1985) concluded that a lower body fat percentage is a key element in the success of national level volleyball players.

Fleck (1983), and Wilmore and Costill (1999) suggest that male body fat percentage should be 11-14%, which is similar to our results (Table 1). Opposite hitters (14.00±1.64%) had slightly higher values in % body fat than other players, but it was not statistically significant (Table 3). No significant difference was found among playing positions for jumping performance (Table 3). This could be explained by the fact that stretch-shortening cycle movement patterns are performed in all volleyball positions (Marques et al., 2009). Moreover, although setters, outside players and liberos are shorter and consequently have a lower standing reach height, they have similar absolute Vertical jump (VJ) and spike jump (SJ) heights as middle blockers and opposite hitters (Sheppard et al., 2009). In addition, setters have a modest maximal jumping demand compared with middles and outsides, but their total jump demands during match conditions is actually the highest when submaximal jump sets are included in the analysis (Sheppard et al., 2009).

Modern volleyball game is faster and with a lot of back row attacks conducted from opposite and outside hitters. Therefore, it was expected that this players could have the greatest values in standing broad jump (SBJ). Our results show no statistically significant difference in SBJ test among positions (Table 3).

Conclusion

The results of this study indicate that significant difference exist among youth volleyball players of different playing positions for body height, body weight and standing reach height. However, no difference was found for body mass index, body fat percentage and jumping performance. Some authors have stated that the height is an important factor of volleyball talent. However, it is important that talent identification should also consider jumping and speed ability as essential component. Therefore, the coaches and sport scientists' goal should be to develop these two components in volleyball players. The limitation of this study was the smaller number of subjects. It would be of great importance to do a similar research with a larger group of participants. Nevertheless, this research has it's value because the Serbian players have achieved great results in past years in top level championships. It can not be concluded that volleyball players develop distinctive performance characteristics at this age and level. Therefore, more researches must be conducted in order to understand better selection and training process that consider positional roles and demands.

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POZICIJSKE RAZLIKE U TJELESNOJ KOMPOZICIJI I IZVOĐENJU SKOKOVA MLADIH ELITNIH ODBOJKAŠA

Sažetak

Cilj ovog istraživanja je bio utvrđivanje pozicijskih razlika u sastavu tijela i izvođenju skokova mladih elitnih odbojkaša. Istraživanje je provedeno na igračima mlade nacionalne momčadi Srbije (n=28, prosječni uzrast =15.68±0.47 godina). Igrači su kategorizirani kao srednji blokeri (n=7), suprotni smečeri (n=5), vanjski smečeri (n=8), sewrviseri (n=6) i liberi (n=2). Srednji blokeri i suprotni smečeri su najviši rastom (201.57±4.92 cm; 203.00±4.41 cm) i najteži (86.14±6.79 kg; 91.60±6.69 kg) igrači u momčadi. Najniže vrijednosti visine i mase tijela su pronađene kod libera. Rezultati postotka masnog tkiva pokazali su najmanje vrijednosti kod libera (11.60±3.06) a najviše kod suprotnih smečera (14.00±1.64). Rezultati testa izvođenja skokova pokazali su slične vrijednosti za sve pozicije u momčadi bez statistički značajne razlike. Statistički znalajna razlika je pronađena među pozicijama za visinu i masu tijela, kao i za maksimalni dohvat. Nije moguće zaključiti da odbojkaši razvijaju distinktne značajke performansi u ovom uzrastu i razini. U svakom slučaju, treba provesti dodatna istraživanja kako bi se bolje razumjelo selekciju i trenažni process koji se tiču pozicijskih uloga i zahtjeva.

***Ključne riječi**: antropometrija, skakanje, smeč, blok, Indeks tjelesne mase*

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