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Body composition is related to motor abilities of female volleyball players

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Abstract

Success in volleyball certainly depends on the morphological characteristics of the volleyball player, while no technical element can be properly performed without adequate motor abilities. Most of the previous researches only studied the body composition of volleyball players or the researches were conducted on volleyball players in the elite level of the competition. In this regard, the aim of this research was to determine the relationship between body composition and motor abilities in female volleyball players of lower level competition. The sample of respondents consisted of female volleyball players of the women's voleyball club "Student" from Niš who play in the second league "Istok" with an average chronological age of 21.4 ± 2.95 years, who trained volleyball for an average of 10 ± 2.73 years. First, the subjects' body composition parameters were measured (body height, body mass, BMI, fat percentage, muscle percentage), followed by agility tests (Agility T-test, Illinois, Change of direction and acceleration Test (CODAT)), speed (sprint at 10m, 20m and 30m), and explosive strength (Counter Movement Jump (CMJ), Counter Movement Jump With Arm Swing (CMJwas), Squat Jump (SJ)). Based on the obtained results, it could be concluded that there was a statistically significant correlation between body composition parameters and motor abilities of volleyball players in the area of explosive strength and agility. Female volleyball players who had lower body mass and body height achieved better results on explosive strength tests, while volleyball players who had lower body fat and muscle mass % achieved better results on agility tests.

Keywords: *volleyball, body composition, explosive strength, agility, speed*

Introduction

Volleyball is a specific sport that is played over a net where there is no direct contact with the opponent. It represents top technique, strategy and tactics, requires a certain speed of movement, and attracts all groups of participants and spectators (Janković, & Marelić, 1995). As a complex sports branch, volleyball abounds in different motor forms. It is defined as a "polystructural complex sport" in which players demonstrate technique, tactics, motor skills and abilities in order to achieve certain results and achieve success (Janković, & Marelić, 1995). Motor abilities (coordination, explosive power, agility, speed) are one of the factors that certainly have a high coefficient of influence on the quality performance of volleyball players (Magill, 2007).

Success in volleyball certainly depends on the morphological characteristics of the volleyball player, where the basic ones are body height and mass, which are valued considering the current age of the volleyball player (Marelić, Đurković, & Rešetar, 2008). In every sports activity, even in volleyball, no technical element can be properly performed without adequate motor skills and abilities, which cannot be fully expressed without a rational technique of performing movements (Bokan, 2009). The motor abilities that define volleyball players are explosive power in jumps and speed in performing fast, multidirectional movements (agility) (Ciccarone, Croisier, Fontani, Martelli, Albert, et al, 2008). In addition to high technical and tactical skills, the development of motor skills and abilities, as well as appropriate body composition is necessary in volleyball. It has been found

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that success in volleyball is directly related to explosive power of the lower extremities, speed, and a low percentage of body fat (Şimşek, Ertan, Göktepe, & Yazıcıoğlu, 2007; Koç, & Aslan, 2010; Çon, Akyol, Tural, & Taşmektepligil, 2012).

The identification of specific body characteristics that can contribute to success in sports, as well as possible structural differences between athletes in different sports, has been the subject of great interest among sports scientists and coaches (Zaccagni, & Gualdi-Russo, 1996; Duncan, Woodfield, & al-Nakeeb, 2006). Also, the importance of anthropometric characteristics and its influence on motor abilities, volleyball technical skills and psychophysiological characteristics was studied in female volleyball players aged 13-16 years (Stamm 2003; 2006). Body composition determined 42-89% of the results of motor abilities tests, up to 32% of volleyball technical skills tests and up to 43% of psychophysiological tests. Furthermore, there are many studies that compare only the body composition of volleyball players with players of other sports (Bayios, et al., 2006), from other countries (Ayan, et al., 2012; Cabral, et al., 2008; Duncan, et al. 2006; Milic et al., 2012), and at different levels of competition and playing positions (Carvajal, et al., 2012; Gualdi-Russo, & Zaccagni, 2001; Malousaris, et al., 2008). In most cases, previous studies has dealt only with the body composition of female volleyball players, or the studies were conducted on female volleyball players in the elite level of competition.

Therefore, the aim of this study was to determine the correlation between body composition and motor skills in volleyball players of a lower level of competition.

Methods

The sample of respondents

Fifteen volleyball players of the women's volleyball club "Student" from Niš, who play in the second league "Istok", with an average chronological age of 21.4 ± 2.95 years, who has been training volleyball for an average of 10 ± 2.73 years, participated in this study. Before testing, all respondents were familiarized with the protocol and gave voluntary consent to participate in the study.

Testing procedure

The testing was carried out in the evening hours in the hall intended for volleyball. First, there was a 15-minute warm-up, which consisted of various movement exercises and exercises specific to one volleyball training session, in order for the respondents to prepare their body for the tests.

Body height was measured by anthropometry according to Martin GPM 101 (GPM GmbH Switzerland) with an accuracy of 0.1 cm. The respondents stood with their backs resting on the anthropometer, maximally stretched with their heels together, the handle of the anthropometer was placed on the highest point of the crown and the body height was read. (Madić, Nikolić, & Stojiljković, 2015). Then, the respondents' body mass, body mass index, fat percentage, muscle percentage and daily metabolism were measured using bioelectrical impedance Omron BF511 (Kyoto, Japan) with an accuracy of 0.1 kg. The respondents stood barefoot on the instrument with their arms in front of them at shoulder height holding the bioelectrical impedances.

Optojump photoelectric cells were used to evaluate explosive power. The respondents performed three static tests to assess explosive power: Squat Jump (SJ), Counter Movement Jump (CMJ) and Counter Movement Jump With Arm Swing (CMJwas). The SJ test is performed with the hands fixed on the hips while the starting position is a half-squat from which the maximum vertical jump is performed. The CMJ test is also performed with the arms fixed on the hips while the respondent moves from an upright position to a semi-squat position after which she performs a maximal vertical jump, the CMJwas the same starting position as the CMJ except that the respondent also uses arm swing (Madić, Nikolić, & Stojiljković, 2015).

The respondents' running speed was tested using Witty photocell gates (Microgate, Italy) with an accuracy of 0.01s (Madić, Nikolić, & Stojiljković, 2015). The test subjects had the task of running a given section from a high start, at the signal of the meter, in the shortest possible time interval. Witty photocell gates were placed at 5, 10 and 20 meters, which displayed information about the passing times.

For the assessment of agility, Witty photocell gates (Microgate, Italy) were also used, which were placed at the start and/or finish in all 3 tests.: Agility T-test, Illinois agility test and Change of direction and acceleration Test (CODAT). In the Agility T-test, the cones are placed in the shape of the letter T, where the distance from the start to the first cone is 9.14m, while the side cones are 4.57m apart. The test subjects had the task of running in a straight line to the first cone and touching it, then with a lateral movement step-by-step run to the left cone which they touch, then with the same step-step to the right side cone which they also touch, return with the same type of movement to the central cone which they touch and finish the test by going backwards to the starting position (Madić, Nikolić, & Stojiljković, 2015). The Illinois agility test involves an area 10m long and 5m wide, where cones were placed in the middle at a distance of 3.33m. Test respondents start at the lower left cone. At the meter's signal, they run to the upper left cone, go around it, then return to the lower center cone and begin a slalom movement between the center cones in both directions. After exiting the figure eight, the subjects run to the upper right cone, go around it and finish the test at the lower right cone (Madić, Nikolić, & Stojiljković, 2015). In the CODAT test, the respondents ran a sprint for 5m, then a zigzag sprint for 3m each, which is performed at angles of 45° and 90°, and finished the test with a sprint for the remaining 10m (Lockie, Schultz, Callaghan, Jeffriess, & Berry, 2013).

Statistical data processing

Statistical data processing was done using the IBM SPSS Statistics 20 program. Since the normality of the data was confirmed by the Kolmogorov-Smirnov test, we used Pearson's correlation analysis to determine the correlation between body composition and motor abilities of female volleyball players. The correlation coefficient was presented as follows: trivial ($0 < r < 0.1$), small ($0.1 < r < 0.3$), moderate ($0.3 < r < 0.5$), large ($0.5 < r < 0.7$), very large ($0.7 < r < 0.9$) and almost perfect ($0.9 < r < 1$).

Results

Descriptive parameters of body composition and motor abilities, as well as the normality of data distribution are shown in Table 1. The average height of volleyball players was 176.66 ± 7.19cm, while the average body mass was 65.70 ± 7.44kg. The average percentage of fat was 27.24 ± 4.69%, and the average percentage of muscle mass was 31.19 ± 2.76%. BMI is categorized according to World Health Organization data: under 18.5 kg/m2 (underweight); from 18.5 - 24.9 kg/m2 (normal body mass); from 25.0 to 29.9 kg/m2 (overweight) and above 30.0 kg/m2 (obesity) (WHO, 2000). Given that the average BMI was 20.93 ± 1.86, it can be concluded that the volleyball players had normal body mass.

Detailed presentation of the correlation between body composition and motor abilities of female volleyball players is pre-

Table 1. Descriptive statistics and normality of data distribution

	Mean ± Std. Dev.	K-S (Sig.)
BH (cm)	176.66 ± 7.19	0.640
BM(kg)	65.70 ± 7.44	0.950
BMI	20.93 ± 1.86	0.672
BF%	27.24 ± 4.69	0.865
Muscle (%)	31.19 ± 2.76	0.904
CMJ	27.50 ± 3.53	0.661
CMJwAS	31.67 ± 3.90	0.989
SJ	26.94 ± 3.83	0.643
5m	1.29 ± 0.109	0.986
10m	2.16 ± 0.13	0.986
20m	3.76 ± 0.18	0.945
Ilinois	18.07 ± 0.67	0.916
T test	11.62 ± 0.89	0.958
CODAT	6.34 ± 0.48	0.960

Legend: K-S (Sig.) – Kolmogorov-Smirnov test; BH (cm) – body height; BM (kg) – body mass; BMI – body mass index; BF (%) – percentage of body fat; Muscle (%) - muscle percentage; CMJ – country movement jump; CMJwAS – country movement jump with arm swing preparation; SJ – squat jump; 5m – sprint for 5 meters; 10m – sprint for 10 meters; 20m – sprint for 20 meters; Illinois - agility test; T-test – test for assessing agility; CODAT - change of direction and acceleration test

sented in Table 2.

Based on the Pearson's correlation analysis, shown in Table 2, it could be concluded that there was a statistically significant correlation between body composition parameters and motor abilities of female volleyball players in the area of explosive strength and agility.

Table 2. Results of Pearson's correlation analysis.

	CMJ	CMJwas	SJ	5m	10m	20m	Illinois	T-test	CODAT
BH (cm)	0.272	0.044	0.016	0.263	0.120	0.106	0.427	0.055	0.445
BW (kg)	0.144	0.027	0.041	0.620	0.443	0.774	0.753	0.920	0.531
BMI	0.717	0.628	0.964	0.668	0.554	0.247	0.747	0.094	0.155
BF%	0.346	0.205	0.437	0.710	0.795	0.499	0.679	0.048	0.015
Muscle (%)	0.469	0.258	0.401	0.619	0.696	0.441	0.694	0.025	0.017

Legend: K-S (Sig.) – Kolmogorov-Smirnov test; BH (cm) – body height; BW (kg) – body weight; BMI – body mass index; BF (%) – percentage of body fat; Muscle (%) - muscle percentage; CMJ – country movement jump; CMJwas – country movement jump with arm swing preparation; SJ – squat jump; 5m – sprint for 5 meters; 10m – sprint for 10 meters; 20m – sprint for 20 meters; Illinois - agility test; T-test – test for assessing agility; CODAT - change of direction and acceleration test

Discussion

There is clear scientific evidence of a strong correlation between body composition and motor abilities in athletes. In addition to high technical and tactical skills, the development of motor skills and abilities, as well as appropriate body composition is necessary in volleyball. Success in volleyball has been found to be directly related to lower extremity explosive power, speed, and low body fat percentage (Şimşek et al., 2007; Koç, & Aslan, 2010; Çon et al., 2012). In this regard, the aim of this research was to evaluate the relationship between body composition and motor abilities of female volleyball players.

Based on the results shown in Table 2, it can be seen that there was a statistically significant correlation between body composition parameters and motor abilities of female volleyball players in the area of explosive strength and agility. A positive correlation of body composition and motor abilities was observed between the following variables: body height (BH) and body mass (BW) were positively related to explosive power (CMJwAS, SJ), while body fat percentage (BF%) and muscle mass percentage were also positively related to agility (T-test, CODAT). The results of this study were consistent with the results of studies that had the same subject. Namely, a large number of studies (Aslan, Büyükdere, Köklü, Özkan, & Özdemir, 2011; Şimşek et al., 2007; Almuzaini, 2007; Günay, Erol, & Savaş, 1994; Acar, Eler, 2019) found a positive correlation between variables of body composition and motor abilities of volleyball players. Also, there are data that establish a positive correlation between body composition and motor abilities in other athletes (Moncef, Said, Olfa, & Dagbaji, 2012; Copić, Dopsaj, Ivanović, Nešić, & Jarić, 2014). Białoskórska et al. (2016) found a significant correlation between body composition and explosive power in a similar sample, which was also noted in the study (Silvestre, West, Maresh, & Kraemer, 2006).

Female volleyball players who had lower BM and BH achieved better results on explosive strength tests, while volleyball players who had lower BF% and percentage of muscle mass achieved better results on agility tests. Finally, the results of the current study were in accordance with the previous literature that studies the given topic, thus we suggest that there is a statistically significant correlation between body composition parameters and motor abilities of female volleyball players.

Conclusion

There is a clear scientific evidence of a strong correlation between body composition and motor abilities in female volleyball players. Motor abilities and body composition have an impact on the success of the sports performance. A positive correlation of body composition and motor abilities was observed in BH and BM variables with explosive power, while BF% and muscle mass percentage were positively related to agility. Our results indicate that there is a statistically significant relationship between body composition parameters and motor abilities of female volleyball players.

Limitation of the study

This study has potential limitations. The first limitation is the small sample size. Therefore, it is desirable to conduct such research with a larger sample of respondents. Another limitation is the number of measuring instruments (tests) that were used in the assessment of the domain of motor abilities. Namely, it is recommended to use a larger number of tests of motor abilities, including tests for assessment of motor skills for conditions specific to the game of volleyball.

Conflict of interest

The authors declare that there is no conflict of interest.

Future research

For future research, it is recommended to use a larger number of motor ability tests and aslo motor skills test that are closer to the conditions specific for the vollyeball game. Also, it is desirable to have a larger sample of respondents.

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