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Original empirical article

THE MULTICENTROID POSITION OF THE ANTHROPOMORPHOLOGICAL PROFILE OF FEMALE VOLLEYBALL PLAYERS AT DIFFERENT COMPETITIVE LEVELS

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Abstract. *The aim of the paper was to determine which anthropomorphological (AM) features are possessed by players who competed at the elite international level (Olympic Games), at the elite national level (Super League) and the federal level (second division - North) in order to classify the most important AM characteristics that determine competitive performance in volleyball for women. A set of 11 variables, measured by standardized tests in field measurement conditions, was used for the assessment of their anthropomorphological profiles. The data were processed by a multivariate statistical method. The results showed that there is a general statistically significant difference in the AM profiles between female volleyball players of different competitive levels (Wilks' Lambda Value-0156, F=4927, 0000 and p=0.000) mostly in body height, LBM, body weight and upper leg skin folds. In terms of selection and in function of AM space, the top female volleyball players must be of above-average height and with morphological features which provide them with an outstanding speed-explosive motor potential.*

Key words: *Anthropomorphological variables, volleyball, multivariate analysis, centroid model*

INTRODUCTION

Volleyball, as a sports game, requires from the players high level preparedness with respect to all the motor abilities, as well as an efficient execution of necessary technical and tactical game elements (TE-TA) (Ćopić & Nešić, 2009; Ercolessi, 1999; Nešić, 2008). In addition to these characteristics and abilities, it was established that volleyball

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players compared to most other athletes have distinctive anthropomorphological characteristics (Ercolessi, 1999; Janković & Marelić, 1995; Ugarković, 2004). Volleyball as a physical activity positively affects the development of motor abilities such as explosive strength, repetitive strength, speed, and movement coordination. The success of the volleyball play largely depends on movement speed without a ball, speed of rhythm and direction change, agility and jumping ability (Miletić, Miletić, & Maraš, 2008; Nešić, 2008). Additionally, training and competitive efforts and activities in volleyball players, as a long-term effect, significantly affect adaptable mechanisms in relation to oxidative stress and the parameters for its assessment (Martinović et al., 2009).

The dominant motor patterns and structures that are realized during a volleyball game include: 1. spatial motor structure: jumps (in attack, for blocking, for lifting the ball to attack, jump-serve), falls, stepping, running, hitting a ball; 2. time motor structures: active playing time, passive playing time, total duration of the game and plus the required warm-up time; 3. technical-tactical structure, including technical-tactical elements of the volleyball game (serve, service reception, lifting to attack, attack, blocking, field defense, lifting for counter-attack and counterattack), (Janković & Marelić, 1995).

Volleyball games can be played in five sets, which means that a game can last about 90 minutes, during which time a player can perform 250-300 actions dominated by leg muscle explosiveness. Of the total number of actions, jumps comprise 50-60%, fast movements and change of direction in space about 30% and falls about 15%. The average body height of a modern volleyball player is taller than in previous periods and is between 195 and 200 cm. The average high jump of the receivers when spiking, spikers and middle blockers is 345 to 355 cm, and 320 to 335 cm in the block (Ercolessi, 1999). The explosive force and speed strength are dominant in the actions of spiking and blocking, and in most cases scoring depends on them (Milić, Nejić & Kostić, 2008).

The structure of the volleyball game is featured by a number of technical elements of high technical demand, a great number of actions and tactical options, high dynamics and play speed. The latest amendments to the playing rules, where each action results in points, significantly increased the speed of the game requiring thus a high degree of specific physical preparedness from a volleyball player (Marelić, Đurković, Rešater & Janković, 2003). However, acceleration of the game dynamics as well as an improving specific physical preparation of volleyball male and female players overall affected the so-called "game height", i.e., it has been found that a greater number of successful TE-TA activities is realized from higher realization positions (Ercolessi, 1999).

Considering that the body height of volleyball players can be treated as a constant, reaching height in a jump for a spike and block (jumping ability) in this situation depends on the level of the explosive capabilities of leg extensors. As one of the main goals of volleyball training, in addition to improving the TE-TA capabilities and improving of general and specific motor abilities (Kostić, 1995; Rajić, Dopsaj & Pablos Abella, 2008), which in this case represent a variable constant (they can be changed by training up to the limits of biological potential), height as a constant value may represent one of the limiting factors in the selection of volleyball players.

In the process of the athletes' preparation to achieve top results it is necessary to use certain procedures in designing a training program, but also establish a control system of the effects of applied training. Within that system, it is also necessary to define the factors which most influence the competitive result (Milišić, 2007). One of the factors that have a significant impact on the achievement of top sports results is the athletes' anthropomorphological component, which in some sports is essential for the achievement of top sports results (Jukić et al., 2007; Milić, Nejić & Kostić, 2008; Rajić, Dopsaj & Pablos Abella, 2004).

The aim of this paper is to identify those characteristics of anthropomorphological space (AM), which determine the basic longitudinal dimensionality factors, as well as the basic factors of body structure and voluminosity in female volleyball players of different competitive success. In other words, the paper objective is to identify which AM features are possessed by the players who competed at the elite international level (Olympic Games), at the elite national level (Super League) and the federal level (second division - North). This way, the obtained results can be used in the process of selection and tracking of the talented players in women's volleyball in the function of a long-term training process, as well as decision-making procedures and choice of prospectively most qualitative anthropomorphological models of female volleyball players.

METHODS

The main method used in this research is the method of direct measurement in field conditions. All of the anthropomorphological variables were measured using the International Biological Standards (Howley, & Don Franks, 1997; Roche, Heymsfield, & Lohman, 1996; Weiner, & Lourie, 1981). A full 60 minutes before the afternoon training, measurements were carried out by professionally qualified individuals - two professors of physical education.

Subject sample

The study included 40 female subjects of which: 16 were players of the Olympic Serbia team (OS), 12 were players of the Volleyball club "Radnicki" (SL), who competed in the Super League of Serbia, and 12 were players the of the Volleyball club "Kikinda" (DLS), who competed in the Second division-North. In this way, the participants represented the following stratum of trained volleyball players who competed at the elite international (OS), elite national (SL) and regional level (DLS).

The average age and training experience of the examined female volleyball players was 22.7±3.2 and 12.5±2.6 years for the OS, 20.0±2.1 and 7.5±1.7 years for the SL, and 18.4±2.7 and 6.2±2.9 years for the DLS female volleyball players, respectively.

All of the respondents were informed about the subject, purpose and task of the study and in collaboration with their coaches gave their voluntary consent to participate.

Sample of variables

In order to distinguish between players of different competitive levels in volleyball, the simplest, in terms of field measurements, and the most representative, in terms of analytical and diagnostic aspects, tests were chosen that can be used in the function of defining the profile of the anthropomorphological characteristics of female volleyball players (Dopsaj, Nešić, Koropanovski, & Sikimić, 2009; Đorđević-Nikic et al., 2007; Howley, & Don Franks, 1997; Weiner, & Lourie, 1981).

An AM profile was estimated by using the following set of 11 variables:

- Three variables to assess the basic AM features in relation to body composition:
  - Body mass - BM, expressed in kg,
  - Body height - BH, expressed in cm,
  - Body mass index - BMI, expressed in kg/m2.
- Four variables to assess AM status in relation to adipose tissue:
  - upper arm skin fold, i.e., m. triceps - SF_{tric}, expressed in mm,
  - hip skin fold, i.e., m. suprailiac - $SF_{suprail}$, expressed in mm,
  - thigh skin fold, ie. m. quadriceps - SF_{thigh} expressed in mm.
- Four variables to assess AM status in relation to body composition:
  - fat tissue percentage - FAT%, expressed as a percentage,
  - fat-free mass - LBM, expressed in kg,
  - absolute amount of fat - FAT_{aps}, expressed in kg,
  - Index to assess the relation of fat-free mass and absolute amount of fat - LBM / FAT_{aps}, expressed in kg.

Body height was measured by means of the anthropometer with an accuracy of 0.5 cm, body mass was measured by a digital scale with an accuracy of 0.1 kilogram (SECA - Cas, Germany) while skin fold thickness was measured by a caliper (The Body CaliperTM The caliper Co., Inc., NV, USA) with an accuracy of 0.001 m (Dopsaj, Nešić, Koropanovski, & Sikimić, 2009).

The percentage of fat tissue (FAT%), fat-free mass (LBM), and adipose tissue (FAT_{aps}) were calculated on the basis of a standardized procedure (Don Howley & Franks, 1997; Roche, Heymsfield, & Lohman, 1996). The index for the assessment of the muscle-fat relation of tissue (LBM/FAT_{aps}) was also calculated on the basis of a standard procedure (Djordjevic-Nikic, et al., 2007).

Statistical methods

Raw data in the first step were analyzed using descriptive statistics in order to calculate the basic descriptive indicators of the mean value (MEAN) and standard deviation (SD). The MANOVA was used to calculate the general difference between AM spaces variables in the function of the examined subsamples. Individual differences between the analyzed variables of the defined subsamples were established by applying the Bonferroni correction, while the multiple discriminant analysis was used to define the differences of AM space structure in the function of the subsamples (Hair, Anderson, Tatham, & Black, 1998).

RESULTS

Table 1 shows the results of the basic descriptive statistics of the analyzed subsamples, as well as of the overall sample of tested female volleyball players.

Table 2 presents the MANOVA results. It was determined that on the general level there is a statistically significant difference in terms of AM spaces between the tested subsamples of female volleyball players on the level of the Wilks' Lambda Value – 0.156, F relation – 4.927, p = 0.000. Compared to the partial differences, it was established that the subsamples significantly differ in the following variables: BM F relation – 9.02, p = 0.001; BH relation F - 13.91, p = 0.000; BMI relation F - 1.50, p = 0.237; LBM / FAT_{aps} F relation – 3.35 p = 0.046; FAT_{aps} relation F - 2.86, p = 0.070; LBM F relation – 13.37, P = 0.000; relation FAT% F - 3.68, p = 0035; SF_{tric} relation F - 3.71, p = 0034; $SF_{suprail}$ relation F – 9.11, p = 0.001; SF_{thigh} relation F - 7.82, p = 0.001.

Table 1. Results of descriptive statistics

	OS (N = 16)		SL (N = 12)		DLS (N = 12)		Total (N) = 40	
	mean	sd	mean	sd	mean	sd	mean	sd
BM (kg)	71.60^{*}	6.58	$69.44^{\dagger}$	7.15	61.73	4.61	67.99	7.43
BH (cm)	185.41^{*}	7.88	$180.88^{\dagger}$	3.03	174.25	3.07	180.70	7.14
BMI (kg/m^2)	20.81	1.02	21.19	1.75	20.30	0.94	20.77	1.28
LBM/FAT$_{aps}$(kg)	$6.27^{\#}$	1.64	4.98	1.03	5.56	1.07	5.67	1.40
FAT$_{aps}$ (kg)	10.36	2.73	12.01	2.66	9.67	1.86	10.65	2.59
LBM (kg)	61.24^{*}	4.91	$57.43^{\dagger}$	5.36	52.06	3.34	57.34	5.94
FAT% (%)	$14.35^{\#}$	2.93	17.18	2.87	15.58	2.26	15.57	2.91
SF$_{tric}$ (mm)	$10.05^{\#}$	2.93	13.09	3.14	11.92	2.90	11.52	3.19
SF$_{suprail}$ (mm)	7.64^{*}	2.38	9.43	3.05	12.33	3.31	9.58	3.43
SF$_{thigh}$ (mm)	15.52	4.47	$18.99^{\dagger}$	4.24	13.00	1.24	15.81	4.33

Table 2. Results of the general and partial differences of AM spaces in relation to the examined subsamples of female volleyball players

	OS (N = 16)		SL (N = 12)		DLS (N = 12)		Total (N) = 40	
	mean	sd	mean	sd	mean	sd	mean	sd
BM (kg)	71.60^{*}	6.58	$69.44^{\dagger}$	7.15	61.73	4.61	67.99	7.43
BH (cm)	185.41^{*}	7.88	$180.88^{\dagger}$	3.03	174.25	3.07	180.70	7.14
BMI (kg/m^2)	20.81	1.02	21.19	1.75	20.30	0.94	20.77	1.28
LBM/FAT$_{aps}$(kg)	$6.27^{\#}$	1.64	4.98	1.03	5.56	1.07	5.67	1.40
FAT$_{aps}$ (kg)	10.36	2.73	12.01	2.66	9.67	1.86	10.65	2.59
LBM (kg)	61.24^{*}	4.91	$57.43^{\dagger}$	5.36	52.06	3.34	57.34	5.94
FAT% (%)	$14.35^{\#}$	2.93	17.18	2.87	15.58	2.26	15.57	2.91
SF$_{tric}$ (mm)	$10.05^{\#}$	2.93	13.09	3.14	11.92	2.90	11.52	3.19
SF$_{suprail}$ (mm)	7.64^{*}	2.38	9.43	3.05	12.33	3.31	9.58	3.43
SF$_{thigh}$ (mm)	15.52	4.47	$18.99^{\dagger}$	4.24	13.00	1.24	15.81	4.33

Table 3. Structure matrix of the individualized canonical functions of the measured AM space

Structure matrix		
	Function	
	1	2
BH (cm)	**-.465***	-0.316
LBM (kg)	**-.454***	-0.321
BM (kg)	**-.387***	-0.062
SF$_{suprail}$ (mm)	**.379***	0.23
SF$_{thigh}$ (mm)	-0.248	**.653***
FAT% (%)	0.039	**.606***
SF$_{tric}$ (mm)	0.086	**.580***
LBM/FAT$_{aps}$ (kg)	-0.066	**-.563***
FAT$_{aps}$ (kg)	-0.124	**.446***
BMI (kg/m^2)	-0.127	**.233***

The structure matrix of the examined AM space (Table 3) indicates that the subsamples differ with regard to two differently structured canonical functions saturated by the following variables:

- the first canonical function: BH = -0.465, LBM = -0.454, BM = -0.387 and $SF_{suprail}$= 0.379;
- the second canonical function: SF_{thigh} = 0.653, FAT% = 0.606, SF_{tric}=0.580, LBM/FAT_{ADS} = -0.563, FAT_{ADS} = 0.446 and BMI = 0.233.

The results of the defined centroids showed that the subsamples, compared to the first canonical function, significantly differ at the level of Wilks' Lambda Value – 0.156, Chi-square - 61.56, p = 0.000, but such differences were not found in relation to the second canonical function.

Table 4 presents the values of the defined canonical function centroids of the measured AM space when compared to the tested subsamples. In the first function, the OS does not differ from the SL at the level -0.626 of centroids, and from the DLS at the level of -4001 centroids. The SL is different from DLS at the level of -3.375 centroids.

Table 4. The values of the defined centroids of canonical functions of the measured AM space in relation to the examined subsamples.

Functions of group centroids		
Volleyball	Function	
	1	2
Olympic selection	-1.388	-0.645
Super League	-0.762	1.019
Second division –North	2.613	-0.160

Table 5 presents the results of the measured differences of the active state of AM spaces and hypothetical background of players with regard to the obtained models of the discriminant function. It was determined that the AM features are distributed as follows:

- in the Olympic selection 12 (75.0%) players belong to their model, 4 (25.0%) players belong to the super league model, and none belonged to the second division model;
- in the Super League 9 (75.0%) players belong to their model, 2 (16.7%) players belong to the Olympic selection model, and 1 (8.3%) belongs to the second division model;
- in the second division all 12 (100.0%) players belong to their model, and none belong to the Olympic selection model or the Super league model.

Table 5. Results of the classification of female volleyball players with regard to the defined canonical model and the examined subsamples

Classified results					
	Volleyball	teams			sum
		OS	SL	DLS	
Count	Olympic selection	12	4	0	16
	Super League	2	9	1	12
	Second division –North	0	0	12	12
%	Olympic selection	75	25	0	100
	Super League	16.7	75	8.3	100
	Second division –North	0	0	100	100
a. 82.5 % of original grouped cases correctly classified.					

Figure 1 displays the centroid positioning of the studied female volleyball players (OS, SL and DLS) with regard to the observed AM space.

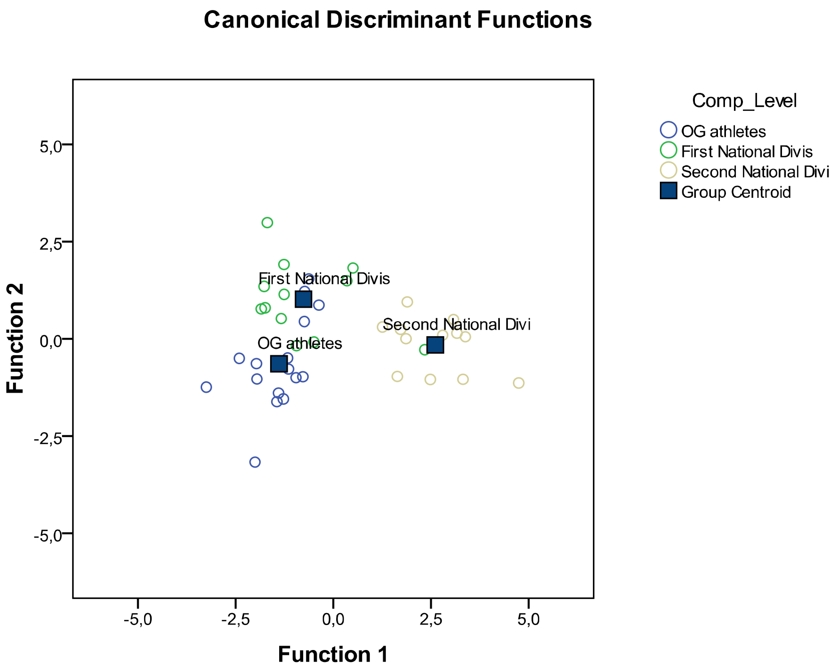

Fig 1. Centroid positioning with regard to the first two canonical discriminant functions

DISCUSSION

Anthropomorphology involves the study of physical characteristics that define the shape and composition of the human body, as well as the study of the fundamental dimensions that describe the given shape or structure (Roche, Heymsfield, & Lohman, 1996; Weiner, & Lourie, 1981). Beside the adequately developed physical skills, as well as the TE-TA game efficiency, competitive success in modern volleyball, as a very dynamic sports game, requires a corresponding profile of anthropomorphological characteristics of players, regardless of gender (Dopsaj, Nešić, Koropanovski, & Sikimić, 2009; Ercolessi, 1999; Nešić, 2008). Also, in relation to the needs of the sports training technology, it is necessary to have profiles i.e., models of all the other spaces of interest for the issues of sports training, selection, and different ages of athletes, in relation to different competitive levels or to a position in the team (Janković, Matković, & Marelić, 1997; Marrin, & Bampouras, 2008; Martinović et al., 2009; Miletić, Miletić, & Maraš, 2008; Milić, Nejić, & Kostić, 2008; Rajić, Dopsaj, & Pablos Abella, 2004).

The results of this research have shown that there is a general statistically significant difference between the AM area of female volleyball players which compete at different competitive levels - the elite international (OS), elite national (SL) and regional (DLS) level at the level of MANOVA Wilks' Lambda Value 0.156 , F=4.927, p=0.000 (Table

2). With regard to individual variables it was revealed that the groups differ in: body mass BM (p=0.001), body height BH (p=0.000), the index for the assessment of the fat-muscle mass relation LBM/FAT_{aps} (p=0.046), fat-free mass LBM tissue (p=0.000), the absolute amount of fat FAT_{aps} (p=0.035), as well as in all the skin folds – triceps SF_{tric} (p=0.034), suprailiac $SF_{suprail}$ (p=0.001), upper leg SF_{thigh} (p=0.001) (Table 2).

With regard to the structure of differences of individual variables between the examined groups (Table 1) the Bonferroni test showed the following differences:

- The OS and SL are different compared to the relative amount of body fat (FAT% p = 0.030) where it was found that the OS athletes had the lowest percentage of body fat (14.35%), compared to the fat component distributed in the upper arm (SF_{tric} p = 0.034), based on which we can conclude that the OS athletes have the lowest percentage of upper arm fat distributed (10.05 mm) as in the relation of the fat-free and fat component (LBM/FAT_{aps} p = 0.044), used to assess the dominance of contractile tissue (dominant muscle tissue) and ballast tissue (predominantly adipose tissue). On the basis of this we can determine that OS athletes have a higher percentage of occurrence of contractile tissue compared to ballast tissue (6.27kg of contractile tissue i.e., fat-free mass per 1 kg of ballast tissue i.e., fat);
- The OS and DLS are different with regard to BH, BM, LBM and $SF_{suprail}$ where OS athletes are taller in a statistically significant manner (p=0.000), heavier (p=0.001), have greater fat-free body mass i.e., contractile component (p=0.000), and have lower distribution levels of fat tissue in the trunk i.e., hip (p=0.000);
- The SL and DLS are different with regard to BH, BM, LBM and SF_{thigh} where SL athletes are taller in a statistically significant manner (p=0.017), heavier (p=0014), have greater fat-free higher body mass i.e., contractile component (p=0.022), and have a higher level of fat distribution of fat tissue on the caudal part of the body i.e. upper leg (p=0.001).

Based on the results of the multiple discriminant analysis it can be concluded that on the general level the groups differ significantly with respect to space made up of the following variables: BH, LBM, BM and $SF_{suprail}$ which have been selected as the first discriminant factors in the difference of the AM space (Wilks' Lambda Value - 0155, Chi-square - 61.56, p = 0.000) in the studied group of female volleyball players (Table 3).

In other words, based on the results we can conclude that on the general level, longitudinality, as a dimension of length body features, represented by the BH variable, is the AM dimension in which the tested female volleyball players differ substantially (OS BH 185.41 cm vs. 180.88 cm SL BH vs. DSL BH 174.25 cm, respectively - Table 1, F = 13.91 - Table 2). The next AM dimension with the highest difference is LBM which predominantly represents muscle mass, i.e., indirectly points to the contractile potential of the athletes (OS LBM 61.24 kg vs. SL LBM 57.43 kg vs DSL LBM 52.06 kg, respectively - Table 1, F = 13.37 - Table 2). The other two dimensions BM and $SF_{suprail}$, essentially carry within themselves part of the information variability contained in the LBM dimension, so that the first two mentioned may be considered the original holders of information on the first extracted discriminant factor.

The obtained structure of the first factor only points to the fact that the top sports performance in volleyball, of course, in addition to other physical, psychological or TE-TA-qualities, is conditioned by the dimension of body height and quality muscle mass. In other words, it appears that the most successful volleyball players are extremely taller females, and that they have a morphological basis which provides contractile potential for the realization of fast, explosive and short motor activities and movements. The obtained results indirectly confirmed the latest results of the analysis of competitive activity in female volleyball players where it was established that modern top volleyball performance tends to accelerate the game dynamics, which requires increasingly better specific physical preparedness, i.e., the ability of female players to carry out TE-TA tasks on ever-increasing heights above the net (Ercolessi, 1999).

Although no statistically significant difference was established between the groups in the function of the second discriminant factor (Wilks' Lambda Value – 0.656, Chi-square - 13.2, p = 0.084), the obtained set showed that the distribution of the caudal body part subcutaneous fat tissue i.e., the upper leg, is the dimension which determines it the most (OS SF_{thigh} 15.52 mm vs. SL SF_{thigh} 18.99 mm vs. DSL SF_{thigh} 13.00 mm, respectively - Table 1, F = 7.82 - Table 2). Other variables in the given set of factors are FAT_{aps}, SF_{tric}, LBM/FAT_{aps}, FAT% and BMI. Even this set contributes to the fact that the speed-strength abilities of female athletes, i.e., highly developed and explosiveness and agility, are dominant factors that provide the required level of specific physical preparedness of players, i.e., an adequate specific - motor fitness of female volleyball players (Ercolessi, 1999; Janković, Matković & Marelić 1997; Kostić, 1995; Milić, Nejić & Kostić, 2008; Radovanović & Ignjatović, 2009; Rajić, Dopsaj, & Pablos Abella, 2008).

The results of the multicentroid positioning of the examined groups indicate that the values of the defined centroids of the canonical functions of the measured AM space in relation to the studied subsamples in the first function are far away at the level of -0.626 and -4.001 centroids in OS vs. OS vs. SL and DLS, respectively. The SL is different from the DLS at the level of -3.375 centroids. In this way, a model of multivariate difference expressed in the centroid score was defined (Table 4 and Figure 1).

The battery of variables used for the assessment of AM space, at the level of 82.5% successfully determined the tested groups of volleyball players, and therefore it can be ascertained that the selection of individual variables was successful. Additionally, the defined discriminant model showed valid measurement characteristics in both the Olympic selection and the Super League players at the level of 75%, while for the players of the Second division-North it was at the level of 100% (Table 5).

CONCLUSION

The research had as its aim to determine which AM features are possessed by the players who had competed at elite international level (Olympic Games), at elite national level (Super League) and the federal level (second division - North). The given results provided data to define the structure and set of the measured AM space and the most important AM characteristics which determine competitive success in women's volleyball were individualized.

Statistically significant differences in the AM space were established between the Olympic selection (OS), Super League (SL) and Second division -North (DLS) at the general level, Wilks' Lambda Value – 0.156, F relation – 4.927, P = 0.000, while the partial differences were determined with the following variables: body height (BH), fat-free mass (LBM), body mass (BM), and hip skin fold ($SF_{suprail}$).

The results showed that at the general level, body height is one of the crucial morphological characteristics for the selection of female volleyball players. This can be connected to the tendencies of volleyball development as a sports game, where it is noted that the world's most successful teams realize their technical and tactical (TE-TA) activities from increasingly higher positions. In addition to the aforementioned basic longitudinal dimensionality i.e., body height, the tested athletes predominantly differ in variables that determine body composition, i.e., indicate the relation of muscle (as contractile) and fat (as ballast) tissue, towards the model of domination of contractile compared to ballast tissue.

Even these results can be linked to the trends of development of volleyball as a sport, where in addition to the increasing height of the play, the phenomenon of game acceleration can be noticed. In fact, it was also noted that TE-TA activities are realized in increasingly shorter time intervals, i.e. faster and faster.

It is exactly the profile of an above-average tall player, who is predominantly trained according to the type of speed-explosive motor efficiency that provides the AM basis for achievement of top results in modern women's volleyball.

The used set of 11 AM variables showed a high level of reliability in defining the model of AM profile for female volleyball players at the level of 82.5%, so that it can be recommended as a simple and practical method for implementation both in practice and in further scientific research, dealing with the issues of technology of sports training in female volleyball players.

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MULTICENTROIDNA POZICIJA ANTROPO-MORFOLOŠKOG PROFILA ODBOJKAŠICA RAZLIČITOG TAKMIČARSKOG NIVOA

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Cilj ovog rada je identifikacija onih karakteristika antropo-morfološkog prostora (AM) koje određuju osnovne faktore longitudinalne dimenzionalnosti, kao i osnovne faktore kojim je određen telesni sastav i struktura odbojkašica različite takmičarske uspešnosti. Zadatak rada je da se utvrdi koje AM karakteristike imaju igračice koje su se takmičile na elitnom internacionalnom nivou (Olimpijske igre), na elitnom nacionalnom nivou (Super liga) i saveznom nivou (Druga liga-Sever) radi izdvajanja najvažnijih AM karakteristika koje određuju takmičarsku uspešnost u ženskoj odbojci. Za procenu antropo-morfološkog profila primenjen je skup od 11 varijabli koje su merene primenom standardizovanih testova u terenskim uslovima merenja. Podaci su obrađeni multivarijantnom statističkom metodom. Rezultati su pokazali da postoji generalna statistički značajna razlika AM profila između odbojkašica različitog takmičarskog nivoa (Wilks' Lambda Value – 0.156, F – 4.927, p = 0.000) i to najviše u telesnoj visini, bezmasnom tkivu, telesnoj masi i kožnom naboru nadkolenice. Posmatrano sa aspekta selekcije a u funkciji AM prostora, vrhunske odbojkašice moraju biti nadprosečno visoke i sa morfološkim karakteristikama koje im obezbeđuju nadprosečan brzinsko-eksplozivni motorički potencijal.

Ključne reči*: Antropo-morfološke varijable, odbojkašice, multivarijaciona analiza, kanonički model*