

# **ORIGINAL SCIENTIFIC PAPER**

# Model Morpho-Functional Characteristics of Qualified Volleyball Players

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## Abstract

The significant influence of somatic and functional characteristics on the sports result makes it advisable to justify the model indices of qualified players who are considered to be ideal models in their sport. The purpose of the study was to determine the model morpho-functional characteristics of qualified male and female volleyball players of the Ukrainian Super League. The study involved 12 female and 13 male volleyball players that were qualified as masters of sport, candidates for masters of sports. Morpho-functional diagnostics aimed at determining the body composition of players (fat, muscle, bone components, total water content). According to the results of the anthropometric measurement and morpho-functional diagnostics of qualified volleyball players, we came up with 18 indicators that characterized the constitution and the body composition of athletes' weight. The analysis of the obtained data showed a slight skewness in the distribution of fat and muscle components in the athletes' legs and arms, which was explained by the nature of the volleyball game. The significant potential of Ukrainian volleyball players, the availability of the reserved functional resources was evidenced by their anthropometric indicators of the players of the leading national teams and professional volleyball clubs. The results of the research can serve as a guide and facilitate the selection, training and specialization of gifted Ukrainian youth.

Keywords: volleyball players, Super League, fat content, muscle content, bone components, model

#### Introduction

The development of volleyball at the present stage is characterized by continuous increase in speed and athleticism of the game, constant additions to the official rules aimed at increasing of the entertainment and intensity of matches (Shchepotina, 2015; Malikova, Doroshenko, Symonik, Tsarenko, & Veritov, 2018; Kostiukevych et al., 2019). Stiffer competition among volleyball teams of different levels leads to different researches aimed at identifying the most important factors that determine the effectiveness of competitive activity and the achievement of high sports results on both national and international arenas (Kostiukevych et al., 2019). In particular, Zhelezniak, Portnov, Savin and Leksakov (2004) distinguish 12 components in the structure of the competitive activity of volleyball players, which are based on the morphological indicators (Kostiukevych et al., 2019). Moreover, the basic model of a qualified athlete developed by Kuznetsov, Novikov and Shustin (1975) in addition to the competitive model (first level) and the skilled model (second level), includes the third level – a model of sports resources (morphological indicators, age, athletic experience, functional and psychological characteristics), which is largely contingent on the results of the first two levels.

The analysis of the scientific literature indicates that a great number of researches were devoted to the detailed substantiation of the influence of morpho-functional indicators on the sports results of players (Kostiukevych et al., 2020; Shynkaruk, Shutova,



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Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, Department of Theory and Methodology of Sports, 21100, 32, Ostrozhskyi str., Vinnytsia, Ukraine E-mail: vadimadamchuk@gmail.com Serebriakov, Nagorna, & Skorohod, 2020). In particular, Dopsaj, Nešić and Ćopić (2010) studied the constitutional features of volleyball players of different qualifications, which determined the competitiveness of women's volleyball. In the scientific work of Stech (2010) the correlation analysis proved the interrelation of somatic-age characteristics of volleyball players with the level of their sports mastery, which was determined on the basis of the expert evaluation of the coaches of the efficiency of competitive activity of female athletes. Moreover, Stech (2010), as well as Acar and Eler (2019) substantiated experimentally the influence of somatic characteristics of volleyball players on the jumping performance, which, in turn, significantly determine the effectiveness of performing such technical and tactical actions in volleyball as attack hit and block. It also should be mentioned that in our previous studies (Shchepotina, 2016), the results of correlation analysis were described, which proved the correlation of the morpho-functional characteristics of qualified volleyball players with both their physical fitness and competitive performance.

Therefore, the above mentioned information indicates a significant impact of somatic and functional characteristics on volleyball players' fitness and their athletic performance. As far as qualified athletes are considered to be ideal models in their kind of sport, carefully selected and well-organized model morphological characteristics of these athletes can be used as a guideline and facilitate the selection, training and specialization of gifted youth (Byoung-Goo & Kim, 2005). Therefore, a great number of scientific works were devoted to the establishment of the model of qualified volleyball players of national teams (Valleser et al., 2018) and the leading volleyball clubs (Mala et al., 2015; Muniz et al., 2017). At the same time we consider it necessary to present the model morpho-functional characteristics of the players of female and male teams of the Ukrainian Super League, because of the lack of corresponding attention to the above mentioned problem on the Ukrainian sport arena.

The purpose of the study was to determine the morpho-functional model characteristics of qualified male and female volleyball players of the Ukrainian Super League, including anthropometric data, as well as indicators of the body composition.

### Methods

#### Participants

The study involved 12 female and 13 male volleyball players that were qualified as masters of sport and candidates for masters of sports. The inclusive criteria were to be a starter or an active backup player. They were all the members of the top 4 women and top 3 men teams, according to the results of the Championship of Ukraine among women's and men's teams of the Super League and were located in Vinnitsa (VC "Bilozgar-Medical University" and VC "MHP-Vinnitsa"). Informed consent to participate in this experiment was obtained from all participants. The study was approved by the Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University research ethics committee.

#### Organization of the research

The study was conducted in a competitive period when the players were in their optimal competition form (Kostiukevych et al., 2019). Anthropometric measurement using a standard Stadiometer was performed to obtain the athletes body height. Morpho-functional diagnostics involved determining the body composition of players using a Tanita BC-601. To avoid errors the measurements were taken before physical load and not earlier than in 2 hours: a) after meals; b) after consuming a large amount of fluid; c) after taking a bath or a sauna.

The total body fat (%), total muscle mass (skeletal, smooth, heart muscle together with water) (kg) and their content in the body segments of volleyball players as well as bone mass (inorganic constituents of bone, such as calcium) (kg), total body water (%), body mass (kg) and body mass index (kg·m<sup>-2</sup>) were studied with Tanita BC-601. The obtained data were subjected to the mathematical processing on the basis of statistical methods of processing the measurement results.

Statistical analysis. While the mathematical processing of the results of the study descriptive statistics was used. The studied variables have been described with the mean (M), standard deviation (SD) and coefficient of variation (V). The Student's t-test was used to determine the significance of the differences between male and female volleyball players morpho-functional indicators. The difference between the indicators was considered significant at the significance level p<0.05. The mathematical processing of the study results was carried out using the MS Excel software package (Byshevets et al., 2019).

### Results

All the results obtained in the processing of the initial measurement data of the examined female and male volleyball players are shown in Table 1. The analysis of the table 1 allowed us to note a fairly young age of both female (22.92±5.22 years) and male (21.92±4.19 years) professional teams of Ukraine (p>0.05).

<b>Fable 1.</b> Model morpho-functional characteristics of highly qualified volleyball players of the Ukrainian Supe	er League
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Morpho-functional indices	Statistic indices					
	Female volleyball players (n=12)		Male volleyball players (n=13)		t-test	p-value
	M±SD	V, %	M±SD	V, %		
Age (years)	22.92±5.22	22.8	21.92±4.19	19.1	0.531	0.601
Body height (m)	1.80±0.04	2.2	1.98±0.06	3.2	8.887	0.000*
Body mass (kg)	72.56±4.82	6.6	90.49±11.83	13.1	5.031	0.000*
Body mass index (kg/m <sup>2</sup> )	22.53±2.27	10.1	23.06±2.46	10.6	0.560	0.581
Total body fat (%)	21.52±4.08	19.0	11.42±2.22	19.4	7.599	0.000*
Total muscle mass (kg)	53.98±4.20	7.8	76.10±7.75	10.2	8.963	0.000*
Bone mass (kg)	2.88±0.22	7.5	3.90±0.39	10.0	8.132	0.000*
Total body water (%)	57.13±2.98	5.2	63.06±3.02	4.8	4.939	0.000*

Notes: \* - p<0.05; M - mean; SD - standard deviation; V - coefficient of variation

At the same time, large coefficients of variation (22.8 and 19.1%, respectively) indicated a significant age difference between young and experienced players.

Body height is one of the most stable somatometric indicators, which is largely due to heredity. At the same time, height is of great importance for volleyball, as it can make it easier to compete directly near the volleyball net, which is elevated above the ground for 2.24 m in women and 2.43 m in men. Statistically significant differences could be easily predicted (p<0.05) in the height of the female volleyball players (1.80±0.04 m) and male volleyball players (1.98±0.06 m).

Body mass is an important indicator of general physical development, but it is not sufficiently informative. The body mass index allows to assess the degree of correspondence of a person's mass to his height. The body mass index of female volleyball players (22.53±2.27 kg/m2) and male volleyball players (23.06±2.46 kg/m2) lay under normal limits.

Much attention in our research was devoted to the study of both components: the total body fat and muscle mass of volleyball players, and their content in segments of the body of players (Figure 1, a-b; Figure 2, a-b).



a b FIGURE 1. Model of segmental body fat percentage (%) of qualified volleyball players / female (a) and volleyball players / male (b) of the Ukrainian Super League. 1 – fat percentage in the trunk; 2 – fat percentage in the right arm; 3 – fat percentage in the right leg; 4 – fat percentage in the left leg; 5 – fat percentage in the left arm



a b FIGURE 2. Model of segmental body muscle mass (kg) of qualified volleyball players / female (a) and volleyball players / male (b) of the Ukrainian Super League. 1 – muscle mass in the trunk; 2 – muscle mass in the right arm; 3 – muscle mass in the right leg; 4 – muscle mass in the left leg; 5 – muscle mass in the left arm

The total body fat of qualified female volleyball players was  $21.52\pm4.08\%$  and male volleyball players-  $11.42\pm2.22\%$  (p<0.05). In particular, a part of the body fat was concentrated in the legs of the players (Fig. 1, a-b). It was noticeable that the content of fat component in the players' right leg was slightly higher than the fat content in the left leg (by 0.70% for women and 0.62% for men). In addition, there was more muscle mass in the left leg than in the right: 0.17 kg for both women and men (Figure 2, a-b). The content of fat component in the right arm was lower than in the left arm (0.42% for women

and 1.23% for men), and the content of the muscle mass in the right arm exceeded its share in the left arm (0.24 kg in the women's team and 0.15 kg in the men's team).

In the structure of bone tissue the following components were distinguished: mineral component makes up about 50% of the total bone mass and provides its strength, organic component makes up 40% of the bone mass and ensures its elasticity, fluid – 10% makes up the vascular canals and cellular space (Platonov, 2013). The analysis of bone mass (mass of inorganic substance of bones) of the examined players (2.88±0.220.06 kg

by women and  $3.90\pm0.390.11$  kg by men, p<0.05) revealed a significant excess of the accepted by Tanita norms for women and men, who do not play sports.

The total body water is the largest weight component of the body molecular level. Water plays the key role in many processes in the body: it is contained in every cell, tissue and organ; regulates body temperature, delivers essential nutrients to all organs, removes slag. According to the results of our study, the total body water of female volleyball players was  $57.13\pm2.980$ ; 90% and of male volleyball players –  $63.06\pm3.02\%$  (p<0.05), which was higher than the norm for women and men, who don't play any sports.

### Discussion

The determination of model indicators with the subsequent development of the models of morpho-functional status of qualified athletes at different stages of annual and long-term training creates preconditions for sports improvement in the selected kind of sport due to the organization of selection and orientation, evaluation of readiness for achievement of high sports results, creation of conditions for effective training (Byoung – Goo & Kim, 2005; Kostiukevych et al., 2018). In the context of the above mentioned the model morpho-functional characteristics of qualified Ukrainian male and female volleyball players are innovative and make a significant contribution to the development of Ukrainian volleyball.

According to Wilmore, Costill and Kenney (2012) the body composition of the athlete provides more accurate information about his abilities than the height and weight of the athlete. Excessive body weight of the athlete is usually not a particular problem, while the excess of the body fat usually has a negative effect on the athletic performance. The comparison of the obtained results with the previous ones, in such items as height and body mass, body mass index, total body fat and muscle mass, the total body water showed that the indicators of Ukrainian male and female volleyball players do not differ significantly from the indicators of the players of the leading national teams and volleyball clubs (Malý, Malá, Zahálka, Baláš, & Čada, 2011; Abazi, Milenkovski, Telai, & Zivkovic, 2017; Konstantinos, Panagiotis, & Ioannis, 2019). This speaks for the considerable potential of the Ukrainian athletes, the availability of the reserved functional resources for the future realization in the process of long-term training.

Quite young age of the players, but, at the same time, the high indices of groups' variation of the examined athletes indicate a significant difference in the age between young and experienced players. This proves the relevance of the idea that three generations of players namely young, middle-aged, veterans are to be present in the sports full team (Zhelezniak et al., 2004; Stroganov et al., 2020).

The results of the research conducted by Kutáč and Sigmund (2017) based on the peculiarities of the distribution of fat and muscle components in the body segments (arms, legs and trunk) of qualified volleyball players (male and female) were updated in our research. In particular, the extremely intense skewness of the distribution of fat and muscle components in the athletes' legs and arms was confirmed, which **Acknowledgements** 

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#### **Conflict of Interest**

The authors declare that there are no conflicts of interest.

relates to the nature of the movement activity of players in the volleyball game (all the examined athletes were righthanders). Thus, more load on the left leg while performing a stopping step and repulsion during attack hits cause more content of the muscular component in the left leg compared to the right and, at the same time, greater content of the fat component in the right leg than in the left one. The specificity of the performance of technical elements in volleyball – attack hits, serving, passing, etc., which players mainly perform with the help of the leading right hand, causes the redistribution of the components of the body in the leading arm: the increase of muscle component and reduction of fat.

The significant excess of bone mass (mass of inorganic substances of bones) for women and men, who do not go in for sports, in the examined athletes is also proved by Platonov (2013) and correspond with Tanita norms. This axcess concerns the adaptation of bone tissue under the influence of physical activity, which is manifested in the increase of bone mass and bone strength.

The results of our research confirm the data, that were described in the studies of Nikolaev, Smirnov, Bobrinskaia and Rudnev (2009) concerning the total body water, which may exceed the norm by 5% for average women and men who do not play sports. This stems from the muscle mass of athletes.

#### Conclusions

Generalization of the scientific literature has shown that the prediction of sports results of athletes becomes possible, among other things, on the basis of their constitutional features. At the same time, of great interest is the body composition, which provides comprehensive information about the athletes' resources. In addition, the analysis of the body composition of athletes also allows to correct the training influences in the training process.

In the process of anthropometric measurement and morpho-functional diagnostics (based on bioelectric impedance) of qualified male and female volleyball players 18 indicators that characterize the constitution and body composition of the athletes' were differentiated. The analysis of the obtained data showed a slight skewness in the distribution of fat and muscle components in the athletes' legs and arms, which was related to the nature of volleyball game.

The significant potential of the Ukrainian volleyball players, the reserved functional resources availability, the content of fat and muscle components in the body, which are not significantly different from the similar indicators of the players of the leading national teams and professional volleyball clubs are proved by the anthropometric indicators of the examined athletes.

As qualified athletes are considered to be ideal models in the chosen sport, the obtained indicators of the body composition of the male and female volleyball players of the Ukrainian Super League can be characterized as model and serve as a guideline for assessing the youth perspectives.

The direction for further scientific research is seen in the determination of the model morpho-functional indicators of the athletes of team game sports at the stages of long-term preparation.

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