Original Article

Assessment of body composition of female volleyball players of various performance levels

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Abstract:

The objective of the study was to verify the significance of somatic parameters as performance factors in volleyball. The study included a total of 164 females. Thirty-nine females (age 23.4±2.8 years) were elite volleyball players (G1), 45 (age 23.7±3.7 years) were amateur volleyball players (G2), and 80 (age 22.7±1.3 years) were females from the general population (G3) and represented the control group. The measured parameters included the following: body height; body mass; body fat and its segmental analysis; total body water and its components, extracellular water (ECW) and intracellular water (ICW); and fat free mass and its components, body cell mass (BCM), extracellular mass (ECM), and skeletal muscle mass (SMM). To assess the differences in body composition, values between the test groups, standardized changes in the means (effect size, ES) and 90% confidence limits (90% CL) were used. In female players of a higher performance level, more appropriate values of body composition parameters in terms of performance were observed. The differences between G1 and G2 were *moderate to large*. With increasing player performance, the differences in values increased relative to the values of the G3 control group. An exception to this finding was the absence of a difference in the basic anthropometric parameters (BH, BM) between G1 and G2 players. The results of the study confirmed that body composition parameters were part of the structure of sports performance in volleyball.

Key words: females, athletes, body fat, fat free mass, sports performance.

Introduction

Successful sports training requires knowledge of relevant factors that affect sports performance. Therefore, models of sports performance have been developed that attempt to capture these factors. These models include general models (Grosser & Zintl, 1999; Schnabel, Haare & Krug, 2003) as well as sport-specific models, including sports games. In addition to a number of other factors, all of these models include somatic factors. The somatic factors, also referred to as morphological or constitutional factors, that are most frequently cited by the aforementioned authors include body height, body weight and body composition. Somatic factors are also included in the sports performance structure of volleyball (Dhurata & Enkeleida, 2012; González-Ravé, Arija, & Clemente-Suarez, 2011; Scates & Linn, 2003). In terms of the activities performed during a volleyball match, the basic somatic parameter is body height. However, body composition is also a significant parameter. Body composition is the result of an organism's adaptation to a load during fitness training (Kenny, Wilmore, & Costill, 2012). This adaptation is reflected not only in an athlete's physical fitness and health but is also crucial to motor performance (Malá et al., 2015).

Volleyball is a dynamic game with frequent jumping and playing against gravity (Hank, Zahalka, & Maly, 2015), which requires a high level of physical fitness. The high frequency of jumping during a match was also supported by the results of a study that analysed this particular activity. During the course of four matches, a total of 1087 jumps was observed (Tillman, Hass, Brunt, & Bennett, 2004). To assess physical fitness, frequently used measures are the proportions of body fat (BF) and fat free mass (FFM) in body mass (BM). These are some of the basic parameters of body composition. Contrary to FFM, BF represents inactive body mass. Especially for body cell mass (BCM), BM is a significant factor. Body cell mass is the quantity of all cells that are capable of using oxygen and oxidizing saccharides, thus directly contributing to muscle work (Bunc, 2004). If somatic parameters are included in the structure of sports performance, they should be reflected in different values of these parameters between players of various performance levels. The performance level of an athlete is indicated by his/her membership in a team within a league of a specific performance level. Players with the highest performance levels play in teams within the highest (professional) leagues. Their values on somatic parameters can be considered optimal because they form the basis for maintaining a high level of sports performance and the players' membership in these teams.

There are a number of studies related to body composition in female volleyball players. However, in most of these studies, the authors focus on the players' morphological characteristics, changes in body composition throughout the season, or comparisons of these parameters with those of female players from other sports (Bayios, Bergeles, Apostolidis, Noutsos, & Koskolou, 2006; Carbuhn, Fernandez, Bragg, Green, & Crouse, 2010; González-Ravé et al., 2011; Malá et al., 2015; Martín-Matillas et al., 2014; Tsunawake et al., 2003). The most frequently monitored body composition parameter is the proportion of BF in overall BM. Therefore, in the present study, the authors focused on the identification of body composition with a larger number of parameters and on a comparison of these parameters between players of different performance levels. The study also included a comparison of the monitored parameters with those of the general population of the same age category. The sizes of the differences between the volleyball players' monitored values and those of the general population should also be an indicator of the volleyball players' performance level and degree of readiness for sports performance.

Materials and methods

Participants

The study involved a total of 164 females who were divided into 3 groups. Group 1 (G1) comprised elite volleyball players in the top volleyball league in the Czech Republic who regularly participated in the play-offs. During the competition period, these players underwent 6 volleyball training units per week (15.5 hours per week on average). Group 2 (G2) comprised female volleyball players from an amateur league. During the competition period, these players underwent 3 volleyball training units per week (5 hours per week on average). The control group 3 (G3) comprised females without regular organized physical activity. The basic characteristics of the monitored groups are shown in Table 1. All of the research participants had no health problems and did not take any medications or dietary supplements. All of the tests were carried out during the oestrogenic phase of participants' menstrual cycles. Participation in the research was voluntary; the participants were informed of the course of the research in advance. All participants signed an informed consent to their participation in this research. The research was approved by the Ethics Committee of the University of Ostrava and complied with the Declaration of Helsinki.

Table 1 Basic anthropometric variables of the study groups (mean $\pm$ SD)

Group	n	Age	BH (cm)	BM (kg)	BMI (kg/m ²)
G1	39	23.4 $\pm$ 2.8	179.74 $\pm$ 4.98	70.45 $\pm$ 6.81	21.80 $\pm$ 1.82
G2	45	23.7 $\pm$ 3.7	178.08 $\pm$ 6.32	70.94 $\pm$ 7.02	22.35 $\pm$ 1.54
G3	80	22.7 $\pm$ 1.3	164.00 $\pm$ 5.07	59.56 $\pm$ 10.13	22.18 $\pm$ 3.92

G1 – elite volleyball players, G2 – amateur volleyball players, G3 – general population, n – frequency, BH – body height, BM – body mass, BMI – body mass index, SD – standard deviation

Procedures

The female volleyball players' (G1 and G2) measurements were taken after their completion of the regular volleyball season; in the G3 control group, measurements were taken during the same period. All of the measurements were taken by the same examiner during the morning hours and complied with BIA measurement principles (Kyle et al., 2004). Body height (BH) was measured with Anthropometer A – 2013 (Trystom, Czech Republic), and body mass (BM) and body composition were measured with InBody 770 analyser (Biospace, South Korea). The InBody 770 analyser is a tetrapolar multi-frequency bioimpedance analyser using a frequency of 1,000 kHz; this instrument was simultaneously used as a scale. The measured parameters of body composition included the following: body fat (BF) and its segmental analysis; total body water (TBW) and its components: extracellular water (ECW) and intracellular water (ICW); fat free mass and its components: body cell mass (BCM), extracellular mass (ECM), and skeletal muscle mass (SMM).

Statistical analysis

The data are presented as the mean values and standard deviations (SD). To assess the differences in the monitored body composition values between the groups, the authors followed the recommendations of Batterham and Hopkins (2005) and calculated standardized changes in the means (effect size, ES) and 90% confidence limits (90% CL) for the differences between groups as well as for the changes between time points. The threshold values for ES statistics were < .2 (trivial), $\geq$ .2 (small), $\geq$ .6 (moderate), $\geq$ 1.2 (large), $\geq$ 2.0 (very large), $\geq$ 4.0 (nearly perfect). The exact probabilities and the magnitude of the differences were assessed qualitatively as follows: 25-75% possibly, 75-95% likely, 95-99% very likely, >99% most likely. The smallest worthwhile change/difference was considered to be .2 for the between-individual standard deviation. If the probability of higher or lower differences was > 5%, then the true difference was considered to be unclear (Batterham and Hopkins, 2006; Hopkins, Marshall, Batterham, & Hanin, 2009). Statistical analyses were performed using a statistical spreadsheet (Hopkins, 2006). To complement the comparison of the monitored

parameters of volleyball players (G1, G2) with the values of the general population (G3), the authors used the normalization index (N_i), whose values could be used to assess the development of the monitored indicator.

$$N_i = \frac{M_1 - M_2}{SD}$$

M_1 = mean value of G1 or G2, M_2 = mean value of G3, SD = standard deviation of G3. An N_i value in the range of $\pm .75$ SD showed an average development of the indicator, and an N_i value in the range of $\pm .75$ to 1.5 SD showed a below average (above average) development of the indicator. An N_i value above ± 1.5 SD indicated below average (above average) development.

Results

The mean values of each group's monitored parameters of body composition are presented in Table 2.

Table 2 Body composition profiles (mean $\pm$ SD)

Parameters	G1 (n = 39)	G2 (n = 45)	G3 (n = 80)
BF (kg)	12.45 $\pm$ 3.56	16.48 $\pm$ 4.76	17.31 $\pm$ 7.63
BF (%)	17.43 $\pm$ 3.97	22.9 $\pm$ 4.79	28.03 $\pm$ 7.11
TBW (l)	42.34 $\pm$ 3.33	39.74 $\pm$ 2.71	30.90 $\pm$ 2.80
ICW (l)	26.50 $\pm$ 2.08	24.81 $\pm$ 1.70	19.16 $\pm$ 1.73
ECW (l)	15.84 $\pm$ 1.29	14.93 $\pm$ 1.08	11.75 $\pm$ 1.08
SMM (kg)	32.56 $\pm$ 2.70	30.36 $\pm$ 2.17	23.00 $\pm$ 2.24
SMM (%)	46.33 $\pm$ 2.38	42.99 $\pm$ 3.04	39.14 $\pm$ 3.74
BCM (kg)	32.00 $\pm$ 2.69	28.52 $\pm$ 2.80	21.76 $\pm$ 1.92
ECM (kg)	26.00 $\pm$ 2.48	25.63 $\pm$ 2.85	20.48 $\pm$ 2.39
ECM/BCM	0.81 $\pm$ 0.06	0.90 $\pm$ 0.13	0.94 $\pm$ 0.09
BCM _p (%)	55.18 $\pm$ 2.12	52.38 $\pm$ 4.00	51.58 $\pm$ 2.60
VFA (cm ²)	50.01 $\pm$ 16.86	68.86 $\pm$ 24.87	76.01 $\pm$ 42.61

Segmental analysis (BF %)

R Arm	17.04 $\pm$ 5.45	24.44 $\pm$ 6.84	34.07 $\pm$ 8.13
L Arm	17.75 $\pm$ 5.17	25.52 $\pm$ 6.95	34.61 $\pm$ 7.92
Trunk	18.52 $\pm$ 5.00	24.37 $\pm$ 5.24	28.53 $\pm$ 7.54
R Leg	16.50 $\pm$ 3.25	21.20 $\pm$ 3.79	27.46 $\pm$ 6.17
L Leg	16.48 $\pm$ 3.27	21.09 $\pm$ 3.80	27.33 $\pm$ 6.12

BF – body fat, TBW – total body water, ICW – intracellular water, ECW – extracellular water, SMM – skeletal muscle mass, BCM – body cell mass, ECM – extracellular mass, BCM_p (%) – percentage of BCM in FFM (FFM = BCM+ECM), VFA – visceral fat area, R – right, L – left, G1 – elite volleyball players, G2 – amateur volleyball players, G3 – control group, SD – standard deviation, n – frequency

Comparison of values of elite female volleyball players (G1) and amateur female volleyball players (G2)

Regarding the confidence limits, the differences between BH, BM, and ECM could not be compared (*unclear* differences). For other parameters, the differences could be assessed. For the values of hydration of the organism (TBW, ICW, ECW, ECW/TBW), BF (kg), SMM (kg), and VFA, the differences were found to be moderate (*likely* and *very likely*). A large difference (*likely* and *very likely*) was observed for the following parameters: BF (%), SMM (%), BCM, ECM/BCM, and BCM_p (%).

A segmental analysis of BF distribution revealed large differences in the extremities (*very likely*) and moderate differences (*very likely*) in the trunk (Table 3).

Comparison of values of female volleyball players (G1, G2) and control group (G3)

With regard to the confidence limits, it was not possible to compare the values ECM/BCM, BCM_p (%), BF (kg) and VFA between G2 and G3 (*unclear* difference). The differences between G1 and G3 were moderate (*most likely*) for ECW/TBW, large (*very* and *most likely*) for BM, BF (kg), ECM/BCM, VFA, and for the segmental analysis of the trunk. For other parameters of whole-body as well as segmental analyses, the differences were very large (*most likely*). The differences between G2 and G3 were moderate (*likely* and *very likely*) for BF (%), ECW/TBW, SMM (%), and for the segmental analysis of the left arm and trunk. Large (*very* and *most likely*) differences were observed for BH, BM, ECM, and for the segmental analysis of the right arm and lower extremities (right and left leg). For the hydration parameters (TBW, ICW, ECW), BCM, and SMM, the differences were large (*most likely*) (Table 3).

The large and very large differences (*most likely*) for the hydration values (TBW, ICW, ECW) and for the values expressed in kilograms (BCM, ECM, SMM, BF) were caused by significantly lower BM in G3 females.

Table 3 Between-group differences in body composition profiles

Parameter	G2 vs G1 Standardized difference (90% CL)	Qualitative inference	G3 vs G1 Standardized difference (90% CL)	Qualitative inference	G3 vs G2 Standardized difference (90% CL)	Qualitative inference
BH (cm)	-0.31 (-1.11;0.48)	14/27/60 <i>unclear</i>	-2.98 (-3.48;-2.48)	0/0/100 <i>most likely</i>	-1.93 (-2.51;-1.35)	0/0/100 <i>most likely</i>
BM (kg)	0.07 (-0.6;0.74)	37/39/25 <i>unclear</i>	-1.50 (-2.14;-0.87)	0/0/100 <i>most likely</i>	-1.40 (-2.09;-0.72)	0/0/100 <i>most likely</i>
BF (kg)	1.06 (0.24;1.89)	96/3/1 <i>very likely</i>	1.29 (0.44;2.13)	98/2/0 <i>very likely</i>	0.15 (-0.57;0.88)	46/34/21 <i>unclear</i>
BF (%)	1.29 (0.54;2.05)	99/1/0 <i>very likely</i>	2.51 (1.78;3.24)	100/0/0 <i>most likely</i>	0.93 (0.23;1.63)	96/4/1 <i>very likely</i>
TBW (l)	-0.73 (-1.30;-0.17)	0/5/94 <i>likely</i>	-3.23 (-3.68;-2.77)	0/0/100 <i>most likely</i>	-2.82 (-3.44;-2.21)	0/0/100 <i>most likely</i>
ICW (l)	-0.77 (-1.33;-0.20)	0/5/95 <i>likely</i>	-3.32 (-3.78;-2.87)	0/0/100 <i>most likely</i>	-2.88 (-3.49;-2.27)	0/0/100 <i>most likely</i>
ECW (l)	-0.66 (-1.24;-0.09)	1/8/91 <i>likely</i>	-2.99 (-3.45;-2.53)	0/0/100 <i>most likely</i>	-2.55 (-3.15;-1.94)	0/0/100 <i>most likely</i>
SMM (kg)	-0.76 (-1.33;-0.20)	0/5/95 <i>very likely</i>	-3.32 (-3.78;-2.87)	0/0/100 <i>most likely</i>	-2.93 (-3.54;-2.32)	0/0/100 <i>most likely</i>
SMM (%)	-1.32 (-2.11;-0.52)	0/1/99 <i>very likely</i>	-2.84 (-3.50;-2.18)	0/0/100 <i>most likely</i>	-1.10 (-1.74;-0.45)	0/1/99 <i>very likely</i>
BCM (kg)	-1.22 (-1.89;-0.54)	0/1/99 <i>very likely</i>	-3.57 (-4.00;-3.14)	0/0/100 <i>most likely</i>	-2.09 (-2.66;-1.52)	0/0/100 <i>most likely</i>
ECM (kg)	-0.14 (-0.87;0.58)	21/34/45 <i>unclear</i>	-2.10 (-2.58;-1.61)	0/0/100 <i>most likely</i>	-1.57 (-2.15;-0.98)	0/0/100 <i>most likely</i>
ECM/BCM	1.29 (0.13;2.45)	94/4/2 <i>likely</i>	1.77 (1.17;2.37)	100/0/0 <i>most likely</i>	0.23 (-0.34;0.80)	54/36/10 <i>unclear</i>
BCM _p (%)	-1.24 (-2.37;-0.12)	2/4/94 <i>likely</i>	-2.84 (-3.50;-2.18)	0/0/100 <i>most likely</i>	-0.17 (-0.74;-0.56)	13/40/47 <i>unclear</i>
VFA (cm ²)	1.05 (0.15;1.96)	94/4/1 <i>likely</i>	1.45 (0.48;2.43)	98/1/0 <i>very likely</i>	0.25 (-0.50;1.00)	54/30/16 <i>unclear</i>
Segmental analysis (BF %)						
R Arm	1.28 (0.49;2.06)	99/1/0 <i>very likely</i>	2.94 (2.31;3.58)	100/0/0 <i>most likely</i>	1.22 (0.58;1.86)	99/1/0 <i>very likely</i>
L Arm	1.41 (0.58;2.25)	99/1/0 <i>very likely</i>	3.07 (2.42;3.72)	100/0/0 <i>most likely</i>	1.13 (0.51;1.76)	99/1/0 <i>very likely</i>
Trunk	1.10 (0.42;1.78)	99/1/0 <i>very likely</i>	1.88 (1.24;2.52)	100/0/0 <i>most likely</i>	0.69 (0.00;1.38)	88/10/2 <i>likely</i>
R Leg	1.36 (0.62;2.10)	99/1/0 <i>very likely</i>	3.17 (2.41;3.93)	100/0/0 <i>most likely</i>	1.43 (0.70;2.16)	100/0/0 <i>most likely</i>
L Leg	1.33 (0.59;2.06)	99/1/0 <i>very likely</i>	3.12 (2.37;3.88)	100/0/0 <i>most likely</i>	1.42 (0.70;2.15)	100/0/0 <i>most likely</i>

BH – body height, BM – body mass, BF – body fat, TBW – total body water, ICW – intracellular water, ECW – extracellular water, SMM – skeletal muscle mass, BCM – body cell mass, ECM – extracellular mass, BCM_p (%) – percent BCM in FFM (FFM = BCM+ECM), VFA – visceral fat area, R – right, L – left, G1 – elite volleyball players, G2 – amateur volleyball players, G3 – control group

The between-trial differences are expressed as standardized (Cohen) differences of the mean (90% confidence limits) and ratings of the difference.

Discussion

The female volleyball players of both performance categories (G1, G2) had significantly higher body heights and body weights compared to the control group (G3). This fact is documented by the measured ES values (Table 3) as well as N_i values (Table 4). According to N_i , the values of BH could have been assessed to be highly above average and the values of BM as above average. The higher values of body weight in the female players were caused by their higher BH, which was also shown by negligible differences in BMI values (Table 4). The values of BH and BM between G1 and G2 could not be compared (qualitative inference was *unclear*). However, the identified mean values corresponded with reported values in general elite professional female players (Malá et al., 2015; Martín-Matillas et al., 2014; Zapolska, Witczak, Mańczuk, & Ostrowska, 2014).

The minimal differences in overall BM (Table 1, 3) between G1 and G2 allowed for assessments of the differences in body composition parameters between these two groups and for absolute values (Table 2). The differences in the mean values of BF between G1 and G2 was 4 kg, which represented 5.47% of BF. This difference was also reflected in the higher difference in the proportion of BF for G1 vs G2 than for G2 vs G3. For G1, the proportion of BF (%) was below average in relation to G3; for G2, the proportion of BF was average (Table 4). These differences were also reflected in the segmental analysis values: in all segments, G1 players had the lowest proportion of BF (%); the G3 control group had the highest. The smallest differences were in the abdominal area (trunk segment), which was also confirmed by the VFA values (Table 3, 4). Compared to the G3 control group, greater differences were again observed in G1 players (Table 4). A comparison between the measured values of the proportion of BF (%) in this study's female players and the results of other studies was very problematic. The authors used different methods and analysers, and the resulting values were in the range of 10 – 24% BF (Kenny, Wilmore, & Costill, 2012; Malý, Malá, Zahálka, Balas, & Cada 2011; Malá et al., 2015; Martín-Matillas et al., 2014; McArdle, Katch, & Katch, 2007; Mielgo-Ayuso, Zourdos, Calleja-González, Urdampilleta, & Ostojic, 2015). The mean values in this study's female volleyball players (G1, G2) also fell within this wide range.

The differences in the proportion of BF were also reflected in the different proportions of FFM (BCM+ECM). The differences in their components were crucial to the assessment of FFM. This assessment was expressed by the ECM/BCM index. The higher the proportion of BCM in overall FFM, the lower the value of the index was. This implied that a lower value of the index was a precondition for better physical performance. Values greater than 1 meant that the usability of fat-free mass for muscle work was low (Bunc, 2006), which also indicated a weak precondition for physical performance. In highly trained male athletes (footballers, triathletes), the generally reported values were approximately 0.7 (Kutáč, 2014; Psotta et al., 2007; Psotta, Svěráková, Bunc, Šeflová, & Hráský, 2009). In female athletes, the values were higher. In her study, Malá et al. (2015) focused on body composition in female players of various sports and reported values between 0.73 and 0.80, depending on the specific sport. The values reported for female volleyball players were 0.79 – 0.89 (Malá, Malý, Zahálka, & Bunc, 2010; Malý et al., 2011). Only the mean values of this study's G1 elite female players corresponded to these values. The differences between G1 and G2 and between G1 and G3 reflected the differences in physical activity during volleyball training. A surprising fact was the low level of differences between G2 players and the G3 control group. The differences could not be assessed using ES (qualitative inference was *unclear*) (Table 3); according to N_i , the value of G2 was average with respect to the value of G3 (Table 4). Training sessions undertaken by G2 players were apparently insufficient for the development of the organism for the respective load. The differences were a reflection of the proportion of BCM in overall FFM (BCM_p %). The greatest proportion was observed in G1 elite players; the values of G2 players and the G3 control group could not be compared (Table 3). When N_i was used, the values of G2 players were average (Table 4). FFM also included skeletal muscle mass (SMM). The proportion of SMM depended on the individual's amount of physical activity, which was confirmed by the present study. The greatest proportion of SMM in BM was observed in G1 players, with the lowest in the G3 control group. This fact was confirmed by the identified ES results (Table 3) as well as N_i values. Compared to the G3 control group, G1 players had highly above average values, while G2 players had above average values (Table 4).

The primary parameter measured by the bioelectrical impedance method was water; therefore, the measurement of the organism's hydration was required because the remaining parameters were calculated using these primary parameters (Heymsfield, Lohman, Wang, & Going, 2005). The greatest amount of TBW was observed in G1 players, which was also reflected in their lowest BF value. For a detailed analysis of the organism's hydration, the proportions of ICW and ECW needed to be assessed. ECW serves as a medium for the transport of various substances and consists of the plasma, interstitial lymph, transcellular fluids, and connective tissue fluid. ICW are fluids inside the cells, in which vital processes occur. They closely correspond with skeletal muscle mass, the work-producing tissue of the body (Malina, 2007). An increase in the proportion of ICW in BM leads to an increase in BCM and SMM. In G1 players, the mean value of the proportion of ICW in BM was 37.61% and 34.97% in G2 players. In the G3 control group, it was 32.16%. These differences were also reflected in the differences in the proportions of BCM and SMM among the groups.

Table 4 Values of normalization indices N_i in female volleyball players

Parameter	G1 N_i	G2 N_i
BH (cm)	3.03 SD	2.71 SD
BM (kg)	1.07 SD	1.12 SD
BMI (kg/m ²)	-0.09 SD	0.04 SD
BF (%)	-1.49 SD	-0.72 SD
SMM (%)	1.92 SD	1.02 SD
ECM/BCM	-1.44 SD	-0.44 SD
BCM _p (%)	1.38 SD	0.30 SD
VFA (cm ²)	-0.61 SD	-0.16 SD
Segmental analysis (BF %)		
R Arm	-2.09 SD	-1.18 SD
L Arm	-2.12 SD	-1.14 SD
Trunk	-1.32 SD	-0.55 SD
R Leg	-1.77 SD	-1.01 SD
L Leg	-1.77 SD	-1.01 SD

BH – body height, BM – body mass, BMI – body mass index, BF – body fat, SMM – skeletal muscle mass, BCM_p (%) - percent BCM in FFM (FFM = BCM+ECM), VFA - visceral fat area, R – right, L – left, G1 – elite volleyball players, G2 – amateur volleyball players, N_i – normalization index, SD – standard deviation

Conclusion

In female players of a higher performance level, more appropriate values of body composition parameters in terms of performance were observed. This finding was also confirmed by the increasing differences between these groups and the G3 control group with increasing performance. An exception was the absence of a difference in the basic anthropometric parameters (BH, BM) between G1 and G2 players. It was apparent that already at the amateur level, a sufficient value of BH was a necessary prerequisite for an athlete to play volleyball.

The results of this study confirmed that body composition parameters were part of the structure of sports performance even in volleyball, and a prerequisite to achieve an elite performance level was adequate fitness training, a precondition for adequate adaptation and optimal development of somatic parameters.

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