THE PROFILE AND COMPARISON OF BODY COMPOSITION OF ELITE FEMALE VOLLEYBALL PLAYERS

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Original scientific paper
UDC 796.325:796.034.6-055.2 (437.6)

Abstract:

The authors present the profile and comparison of body composition of the female national volleyball team of the Slovak Republic (senior team – SNT, U19 and U17). The body composition was identified with the use of the multi-frequency bioimpedance method (BIA 2000M). The monitored parameters included the amount of lean body mass (LBM), intra- (BCM) and extracellular mass (ECM) and BCM proportion in LBM (CQ), fat mass (FM), the phase angle indicating cell quality (α), total body water (TBW) and its distribution into intra- (ICW) and extracellular liquid (ECW). The authors recorded the values of female volleyball players indicating their good training load and corresponding to the values characterizing high-performance sport even in the category U17, when this team significantly differed from the senior team (SNT) only in FM ($p<.05$). On the contrary, teams U19 and SNT were significantly different in FM, TBW, α, BCM, ECM/BCM, ICW, ECW and CQ ($p<.05$). We assume that body composition indicators of the team may relate not only to the state of training load (players' physical preparedness) but also to the success of the team at important events.

Key words: *lean body mass, fat mass, elite sport, bioelectrical impedance analysis*

Introduction

In the course of life, the human organism undergoes changes in the biological as well as mental sphere. From the biological perspective, there are changes not only in weight, but also in internal aspects (lean body mass, fat mass, water and its elements, bone density) testifying to the internal composition of the organism. The body composition (BC) may go through individual changes, depending on age, sex, physical activity and sport, somatotype, genetics as well as intra--individual variability.

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. The issues connected with BC in sport, and in volleyball in particular, have been the subject of monitoring for several years (Morrow, Hossler, & Nelson, 1980; Tsunawake, et al., 2003; Bandyopadhyay, 2007 and others).

Information on BC is of multipurpose relevance. It may be used for the estimation of the optimum body weight of athletes and the somatotype suitable for volleyball (Bandyopadhyay, 2007). Body composition may complement the physiological profile of volleyball players (Melrose, Spaniol, Bohling, & Bonnette, 2007). Information on BC may also become an indicator of the nutritional regimen of athletes, and may provide facts about the current homeostasis of body liquids (Andreoli, et al., 2003), it may become a stimulus for recommending changes in the dietary regimen in volleyball players (Hassapidou, 2001) or a stimulus for an adequate supplementation following the sports performance of female volleyball players (n=36, average age= 19-26 years) as part of an adequate physical fitness preparation (Lim, 2003).

The monitoring of BC may also be beneficial for the determination of the adequate volume of load in the design of load diagnostics. The study by Baker and Davies (2006) recommends the method of determining the volume of load on the basis of fat--free mass (FFM) rather than the total body weight of an athlete, which as compared to total weight may underestimate the resulting maximum performance indicators. According to Andreoli, et al. (2003), the BC component record - BCM measurement - is the best predictor of muscular efficiency which may predict sporting performance.

Body composition is also a very important consideration for athletes. Excessive adipose tissue acts as a dead weight in activities where the body mass must be repeatedly lifted against gravity during locomotion and jumping (Reilly, 1996), it slows down the performance, and increases the energy demands of the activity. In contrast, lean body mass contributes to power production during high-intensity activity and provides a greater absolute size and strength for resistance with high dynamic and static loads.

In scientific literature there are not many studies dealing with the comparison of BC of high--performance athletes of one sport discipline and in various age categories. The rising question is whether there are any differences in BC indicators of the best national athletes of the chosen category (U17, U19, senior national team).

The objective of this study was therefore to identify and compare the BC of high-performance female volleyball players stressing the importance of monitoring during the preparation for the national team's competitions.

Material and methods

The screen sample was composed of the best female volleyball players (SNT – senior national team, junior national team – U19 and youth national team - U17) of the Slovak Republic (SNT: n=12, average age=24.00±1.11 years, U19: n=12, average age=18.03±.58 years, U17: n=14, average age=16.64±.48 years). All participants were members of the national team nominated by the Slovak Volleyball Federation for the calendar year of 2009, senior and youth national team members who participated in the European Championship of 2008 or 2009.

Mean body height (BH) was (mean±standard deviation): SNT=179.42±7.32 cm, U19=179.17±6.73 cm and U17=181.50±3.32 cm. Mean body weight (BW) was: SNT=67.75±5.90 kg, U19=66.83±6.93 kg and U17=69.96±5.89 kg. Mean BMI value was: STN=20.46±1.26 $kg \cdot m^{-2}$, U19=20.62±1.22 $kg \cdot m^{-2}$ and U17=21.22±1.33 $kg \cdot m^{-2}$.

The data identifying the participants' BC were recorded under identical conditions, during the morning hours, at the national team's meeting, at the end of the preparatory period, three weeks before the European Championship. In case of U19, data were gathered 2 weeks before qualification at European Championship 2008. Prior to measurements, the participants did not take any medications (at least 24 hours) and the consumption of liquid was controlled (3.3 – 3.5 litres per day). Just before the measurement, the current BW of the participants was read on the electronic scale (Soehnle ©) with a precision of .1 kg, and the body height of the participants in an upright position was measured with a precision of one millimeter. The total body bioimpedance was determined with the use of the BIA 2000 M apparatus (Datainput, 2004), which works on four frequencies (1, 5, 50 and 100 kHz) and is compatible with the NUTRI 4 software. The contact resistance between the electrode surface and the skin did not exceed 250 Ω.

Based on the measured values, the current BC of the chosen groups was determined. We measured the amount of lean body mass (LBM), through its recalculation on kilogram of body weight (LBM/BW) we found out the percentage of fat mass in participants (%FM), fat-free mass (FFM), the values of body cell mass (BCM) and extracellular mass (ECM) and their mutual ratio (ECM/BCM), the percentage of BCM in LBM (CQ), the phase angle (α) and total body water (TBW) with a distinction between extracellular (ECW) and intracellular (ICW) water. Recalculations of individual indirectly measurable parameters identifying the BC quality were based on the respective prediction equations in the software (Datainput, 2004).

The results were expressed in absolute values and percentages, and the evaluation was made with the use of basic statistical characteristics (arithmetic mean, standard deviation). To discover any significant differences between the observed groups analysis of variance was used (one-way ANOVA). In the case of significance between groups we used the *post hoc* Bonferroni's test. Statistical significance was set up at the $p<.05$ level.

Results

In somatic parameters (body height, body weight) we did not find any significant differences in the screened samples (body height $F_{(2,37)}$=.62; p=.544; body weight: $F_{(2,37)}$=.91; p=.413). The total body water mean value (TBW) in SNT was TBW_{SNT}=39.08±2.84 L. In teams U19 and U17 we measured a mutually comparable proportion of TBW (TBW_{U19}=36.20±2.69 L and TBW_{U17}=37.56±2.26 L). The level of TBW between the observed groups was significant ($F_{(2,37)}$=3.72; p=.034). The intracellular liquid value amounted to ICW_{SNT}=22.97±.86 L, i.e., 58.78±3.74% of total body water (TBW) and 34.91±1.27% of the mean body weight. In the junior team (U19) we measured ICW_{U19}=21.87±.67 l (60.41±1.46% TBW) and ICW_{U17}=22.26±.71 L (59.27±3.22% TBW). The extracellular mean value was ECW_{STN}=16.13±2.04 L (41.27±5.22% TBW), ECW_{U19}=14.25±1.68 L (39.37±3.67% TBW) and ECW_{U17}=15.27±1.57 L (40.66±4.18% TBW). When measuring ICW we found out significant differences between the groups ($F_{(2,37)}$=6.65; p=.004). Based on the *post hoc* test significant differences between teams SNT and U19 were registered (p<.05). The proportion of ECW in the screened samples was also significant ($F_{(2,37)}$=3.419; p=.044). The lean body mass mean value was LBM_{STN}=58.48±4.70 kg, LBM_{U19}=55.24±4.44 kg and LBM_{U17}=57.07±3.56 kg.

Comparison of LBM between the groups showed no significant differences either in absolute value ($F_{(2,37)}$=1.78; p=.184) or in the relative (LBM per kg of body weight) value ($F_{(2,37)}$=.68; p=.51). Distinguishing between extracellular mass (ECM) and body cell mass (BCM), in all three teams a greater

Table 1. Values of parameters indicating body composition and their comparison between selected samples

Parameters		Descriptive statistic				ANOVA		Bonferroni's *post hoc* test
		Mean	SD	Min	Max	F	p	
BH (cm)	U17	181.50	3.32	176.00	187.20	.619	.544	
	U19	179.17	6.73	169.00	189.00			
	SNT	179.42	7.32	165.00	189.00			
BW (kg)	U17	69.96	5.89	59.60	78.80	.907	.413	
	U19	66.83	6.93	59.00	81.00			
	SNT	67.75	5.90	58.00	76.00			
TBW (l)	U17	37.56	2.26	33.70	40.70	3.720	.034	U17 vs U19 (p>.05) U17 vs SNT (p>.05) U19 vs SNT (p<.05)
	U19	36.20	2.69	32.90	41.50			
	SNT	39.08	2.84	34.40	44.90			
ICW (l)	U17	22.26	.71	20.60	23.10	6.650	.004	U17 vs U19 (p>.05) U17 vs SNT (p>.05) U19 vs SNT (p<.05)
	U19	21.87	.67	21.00	23.10			
	SNT	22.97	.86	21.30	24.60			
ECW (l)	U17	15.27	1.57	13.10	17.70	3.419	.044	U17 vs U19 (p>.05) U17 vs SNT (p>.05) U19 vs SNT (p<.05)
	U19	14.25	1.68	12.00	17.20			
	SNT	16.13	2.04	12.70	20.40			
LBM (kg)	U17	57.07	3.56	51.10	62.50	1.776	.184	
	U19	55.24	4.44	49.80	64.06			
	SNT	58.48	4.70	50.60	67.70			
LBM/BW	U17	.74	.05	.65	.83	.683	.512	
	U19	.75	.04	.68	.83			
	SNT	.76	.09	.51	.84			
BCM (kg)	U17	27.27	1.51	24.30	29.50	10.068	.000	U17 vs U19 (p>.05) U17 vs SNT (p>.05) U19 vs SNT (p<.05)
	U19	25.63	1.79	23.90	29.00			
	SNT	29.10	2.34	25.00	33.50			
ECM (kg)	U17	24.01	1.94	21.70	27.70	.099	.906	
	U19	23.97	2.49	20.90	27.60			
	SNT	24.33	2.28	20.10	27.90			
ECM/BCM	U17	.88	.06	.79	.99	4.445	.019	U17 vs U19 (p>.05) U17 vs SNT (p>.05) U19 vs SNT (p<.05)
	U19	.94	.10	.82	1.14			
	SNT	.84	.08	.73	.98			
α (°)	U17	6.29	.35	5.60	6.90	4.856	.014	U17 vs U19 (p>.05) U17 vs SNT (p>.05) U19 vs SNT (p<.05)
	U19	5.98	.51	5.70	7.40			
	SNT	6.58	.55	5.70	7.40			
CQ (%)	U17	53.36	1.73	50.30	56.00	4.501	.018	U17 vs U19 (p>.05) U17 vs SNT (p>.05) U19 vs SNT (p<.05)
	U19	51.76	2.52	46.80	54.90			
	SNT	54.48	2.44	50.50	58.00			
FM (%)	U17	18.26	3.03	12.50	24.00	11.935	.000	U17 vs U19 (p>.05) U17 vs SNT (p<.01) U19 vs SNT (p<.01)
	U19	18.03	2.22	15.40	22.60			
	SNT	13.72	2.42	10.90	18.10			

Legend: BH – body height, BW – body weight, TBW – total body water, ICW – intracellular water, ECW – extracellular water, LBM – lean body mass, LBM/BW – relative lean body mass, BCM – body cell mass, ECM – extracellular mass, ECM/BCM – extracellular-intracellular mass ratio, α – phase angle, CQ – cell percentage in LBM, FM – fat mass percentage of body cell mass (BCM) was recorded (BCM_{SNT}=29.10±2.34 kg, BCM_{U19}=25.63±1.79 kg and BCM_{U17}=27.27±1.51 kg; ECM_{STN}=24.33±2.28 kg, ECM_{U19}=23.97±2.49 kg and ECM_{U17}=24.01±1.94 kg. The proportion of ECM in the screened samples was not statistically significant ($F_{(2,37)}$=.10; p=.906). On the contrary, differences of proportion of BCM between groups were significant ($F_{(2,37)}$=10.07; p=.000). Following Bonferonni's *post hoc* test the difference between BCM_{SNT} and BCM_{U19} team was found to be significant (p<.01). Differences between BCM_{U17} and the others were not significant. The ECM/BCM ratio produced a value of .84±.08, which was in accordance with the high phase angle value recorded (6.58±.55º). Comparable values were recorded also in the team U19, where α_{U19}=5.98±.51º following the value of ECM/BCM_{U19}=.94±.10. In the team U17, the mean ratio was ECM/BCM_{U17}=.88±.06 following the phase angle =6.29±.35º. Analysis of variance (ANOVA) proved a significant difference in the ratio of ECM/BCM ($F_{(2,37)}$=4.45; p=.019) even in the phase angle ($F_{(2,37)}$=4.86; p=.014). *Post hoc* tests showed significant differences of the observed parameters between SNT and U19 team (p<.05). The proportion of BCM in LBM (CQ) amounted to CQ_{SNT}=54.48±2.44%, CQ_{U19}=51.76±2.52% and CQ_{U17}=53.36±1.72% ($F_{(2,37)}$=4.50; p=.018). The fat mass mean percentage was FM_{SNT}=13.72±2.42%. In the younger players U19 and U17 a higher mean proportion of fat mass was recorded FM_{U19}=18.03±2.22%, i.e., FM_{U17}=18.26±3.03%). The difference between the variances of the measured values in the screened samples was significant ($F_{(2,37)}$=11.94; p=.000). According to the analysis (*post hoc* test) a significant difference was found between the SNT and both younger teams (p<.01). There was no significant difference (p>.05) between FM_{U19} and FM_{U17}.

Discussion and conclusions

The mean body weight or the Body Mass Index (BMI) values respectively (Table 1), stating the recommended range of body weight and detecting potential excess weight or obesity and health threat risks recorded in this screened sample do not show increased risks of threat to health. These two parameters, however, do not provide us with precise information about the BC of the observed groups, even though some sources point out a high correlation between the percentage of FM and the BMI value (Bandyopadhyay, 2007).

LBM defined by a density smaller than 1,100 $g \cdot cm^{-3}$ and a low amount of essential fat (Lohman, 1992) in the screened sample was LBM_{SNT}=58.48±4.70 kg. In absolute LBM values we have to consider the possibility of a higher proportion of LBM in players with higher BH and BW. Recalculating to a kilogram of body weight, there are relative values (LBM/BW) in the individual teams that are almost identical (Table 1). This is confirmed also by the individual measurement, where absolute LBM values in all three teams in liberos (player's function), or in the youth team in younger players, are lower when compared to other players. Recalculating to a kilogram of body weight, LBM values equalize in the individual players. According to the study of Bandyopadhyay (2007), volleyball players show significantly higher LBM values than the non-sporting population. This parameter, including all body tissues except for fat deposits, is considered a major precondition for a good performance in volleyball. According to Pařízková (1977), LBM compared to total BW is closely related to physiological parameters such as oxygen consumption, cardiac output, vital capacity, etc. Melrose and others (2007) speak of a close correlation of LBM recorded in young female volleyball players (n=29, average age=14.31±1.37 year) with the isometric arm flexion force (r=.90), the isometric leg flexion force (r=.62) and with the ball's velocity after the serve (r=.58). According to the authors, LBM represents one of the key characteristics of physical performance of female volleyball players. Our recorded values point out excellent predispositions for players' performance even in the youth team (U17).

The main parameter of BC will be BCM as a component of LBM, which is represented by metabolically active aerobic cells of skeletal muscles and the heart muscle, internal organs, bones, blood cells and central nervous system (CNS). BCM partially participates in any body motion. According to Andreoli, et al. (2003), the assessment of BCM belongs to the best predictors of muscular efficiency which may predict sporting performance.

The BCM mean value within the screened sample of senior players was 29.10±2.34 kg, in the team U17 we recorded values comparable with values measured in senior players (BCM_{U17}=27.27±1.51 kg) and in the team U19 we found out the lowest value (BCM_{U19}=25.63±1.79 kg). If we expressed BCM as a percentage of the proportion of cells inside LBM and thus as an indicator of the individual nutrition regimen and training load, we would obtain another parameter characterizing the LBM (CQ) quality. An individual approach to female national team players will provide values near to the recommended 50% (Table 1) for almost all female national team players apart from two members of the U19 team (37.93% and 42.41%, respectively). This smaller deficit refers both to ontogenesis and reserves in the training load, when better predispositions were seen in the youth team rather than in the junior team, which was finally confirmed by the individual performance in volleyball (4th place in the European Championship of 2009 and 13th place in the World Championship of 2009). The team U19 did not qualify for the European Championship. It is advisable to verify these hypotheses by both general and specific motor tests (acceleration, explosive power of lower limbs, the height of smash/block jump, speed of the serve/smash, etc.).

BCM may grow in high-performance athletes up to 60% of LBM (Dörhöfer & Pirlich, 2007). In comparison with standard values of individual parameters, more closely identifying BC, or with values included in the available professional literature, however, we must not neglect the problem of comparison based on the inequality of methodologies of BC identification.

While comparing BCM with ECM (with a metabolically inactive part of the human body), the proportion of BCM in healthy individuals should be higher. In comparing BCM and ECM in our sample, the mean BCM proportion was higher than that of ECM (Table 1). Players of all age categories, therefore, possessed a high proportion of BCM. The amount of body cell mass is conditioned both genetically (body type) and by age, and by the orientation of training (above all, the type of activity in terms of its energy demands) which the players undergo. High-performance female volleyball players, whose training process is regular and long-term, will possess high BCM values as compared to the ordinary population.

Practice stresses the importance of the ratio of both components, ECM/BCM, as a criterion for the assessment of predispositions for muscular activity. For athletes, its values range between .70–1.00 depending on the type of sport (Datainput, 2004). A drop in ECM/BCM in most cases indicates an improved BC level, its decrease, however, may also be caused by a loss of water in the extracellular space, e.g., due to an insufficient consumption of liquid in a period of strain or after strain. The screened teams showed the ECM/BCM ratio in the range of .73–1.14. From the perspective of individuals, the lowest value of the ECM/BCM ratio recorded was .73, but there were also values of .90–.98 in the team SNT, which may be commonly recorded for individuals engaged in recreational sport indicating reserves in the sense of a potential for improvement in the training load or nutrition regimen with regards to individual national team members, or reflecting genetic dispositions for a potential BCM growth in individual players.

Increased values in the teams U19 and U17 (1.05–1.14) may relate to ontogenesis and indicate possible reserves in the observed parameter indicating predispositions for physical activity (muscle activity). However, a significant difference was registered only between U19 and U17. This difference may be caused by the level (quality) of the players from the perspective of physical preparedness and play success at important events.

The BCM value also regulates the energy consumption of the organism specifying its energy demands. It is, therefore, closely linked to the basal metabolic rate, which is the fundamental starting point in the modification of the dietary regimen, the planning of training programmes and other components considered by the coach while increasing the training load.

In relation to the body fat component, the opinions of professional literature concerning its optimal percentage vary. Essential fat which is a component part of organs (marrow, heart, lungs, kidney, brain, etc.) is inevitable for the normal functioning of the organism. Fat also constitutes one of the major components of membranes (in the form of phospholipids), and in combination with proteins it constitutes the “skeleton” of membranes. Reserve or subcutaneous fatty tissue has its role, too – it provides the protection of organs serving as a body heat preserver. However, its excessive amount limits the level of the player’s motion (Reilly, 1996).

During the determination of the fat mass percentage, the value FM_{STN}=13.72±2.42% was found, values recorded in the teams U19 and U17 were higher approximately by about 4.5% (FMS_{U19}=18.03±2.22% or FMS_{U17}=18.26±3.03%). The smaller proportion of the inactive component in women was in accordance with existing literature where Lohman (1992) suggests body fat values for sporting women ranging between 12–16% depending on the type of sport. In the same way, Bandyopadhyay (2007) claims that high-performance volleyball players (n=178, average age=20–24 years) showed a significantly lower percentage of body fat with the manifestation of ectomorphic mesomorphy than the ordinary population with the manifestation of endomorphic mesomorphy.

The reason for a need for fat-free mass and the required absence of the fat component is that the data included in the available sources argue that fat-free mass is in a better correlation to success in sport (maximum aerobic performance, running time, etc.) than the %FM. It has been proved that the magnitude and proportion of this active mass is, unlike total body weight, height and other morphological indicators, closely linked to various functional variables like e.g., oxygen consumption while at rest and at work, cardiac output, circulating blood volume, tidal volume, etc. (Pařízková, 1977).

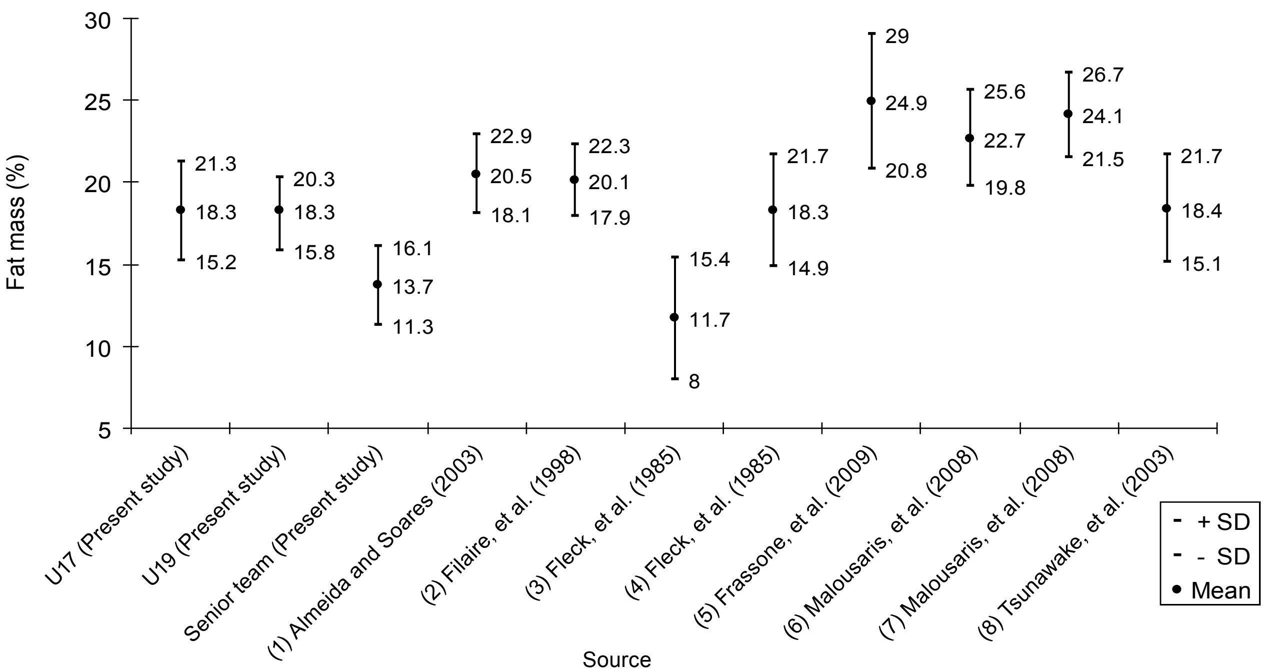
An ideal solution for volleyball players, therefore, implies an increase in active LBM mass with a simultaneous maintenance of the fat tissue proportion, which may be achieved by an appropriate physical fitness preparation with a simultaneous supplementation of creatine (Lim, 2003).

Low fat percentage in the senior team may relate to the fact that all players had the status of professionals and therefore there is the expected professional attitude to the lifestyle and nutrition regimen. Players in clubs undertake regular measurements of the BW. It is also possible to recruit players to a senior national team from a greater range in comparison with younger national teams. Fleck, Case, Puhl, and Van Handle (1985) state a significantly lower value of FM ($p<.01$) in the national team of the USA (11.7±3.7%) when compared with the university team (18.3±3.4%). The method used was hydrodensitometry. Melrose, et al. (2007) measured the mean FM value 21.0±5.5% (by the BIA – Omron method) in female players of a competitive volleyball club (n=13, age 15.5±.6 years, body height 170.0±7.0 cm, body weight 62.8±6.6 kg). Tsunawake, et al. (2003) stated the value of 18.4±3.3% in female players of an inter-high school league (n=12 age 17.4 years, body height 168.7±5.89 cm, body weight 59.7±5.7 kg) by using hydrodensitometry. In literature we may find values even over 20% (Ferris, Signorile, & Caruso, 1995; Nichols, Sanborn, Bonnick, Gench, & Dimarco, 1995; Fillaire, Duche, & Lac, 1988; Almeida & Soares, 2003; Malousaris, et al., 2008; Frassone, Diefenthaeler, & Vaz, 2009). A graphical comparison of fat mass distribution in the screened sample and the selected samples reported in scientific literature is represented in Figure 1.

TBW affects BC and the fat-free mass density and thus also the body fat estimate (%). In the observed groups we found a different level of TBW (Table 1). Analysis of variance proved a significant difference between the measured groups ($p<.05$). Following the *post hoc* Bonferonni's test, a statistical difference in TBW between TBW_{SNT} and TBW_{U19} was proved ($p<.05$). There were no significant differences between TBW_{U17} vs TBW_{U19} or TBW_{SNT}, respectively ($p>.05$). This parameter is very important for the monitoring of performance because states accompanying changes in BC are often connected only with an unfavourable decrease in TBW (e.g., an insufficient consumption of liquids during the training process or regeneration period). During the changes, however, apart from the TBW volume, the distribution of its parts and mainly its intracellular component must also be monitored.

For α (phase angle), which provides us with information on the integrity of cells and allows us to analyse their condition (Dörhöfer & Pirlich, 2007), the standard value considered ranges between 5–7º (Datainput, 2004). In our measurement we recorded the values α_{SNT}=6.58±.55º, α_{U19}=5.98±.51º and α_{U17}=6.29±.35º. The recorded values indicate a high cell quality in all three teams which should also be connected with a higher percentage of intracellular volume and, in the final account, of cell mass as compared to the ordinary population. In an individual assessment, the highest α values in the team SNT were recorded (α =7.20–7.40º).

Relatively high values of TBW, LBM and low values of ECM/BCM (.73–.75) of these female volleyball players indicate their good training load reaching values characteristic of high-performance sport.



Legend: (n, age, level, method)
(1)–25, 16.0±3.6 years, skilled, skinfolds, (2)–7, 24.6±2.6 years, national players–elite, non stated, (3)–12, 23.5±2.6 years, the USA national team-elite, hydrodensitometry, (4) –14, 21.5±0.7 years, female university team, hydrodensitometry, (5)–22, 15.8±2.3 years, non-stated, bioelectrical impedance analysis, (6)–79, 25.7±5.1 years, 1st Greek National League, skinfolds, (7)–84, 22.0±4.4 years, 2nd Greek National League, skinfolds, (8)–12, 17.4 years, inter-high-school league, hydrodensitometry.

Figure 1. Comparison of fat mass distribution in the screened samples and the selected samples reported in scientific literature.

The article presents a BC profile of the Slovak female national volleyball team players of three national volleyball teams. The multi-frequency all-body bioimpedance method detected the values of individual parameters, identifying the BC of female volleyball players, at a level corresponding to high-performance sport as compared to the ordinary population. We deduce that BC indicators may relate to success at important events, when junior and senior team were significantly different in FM, TBW, α, BCM, ECM/BCM, ICW, ECW and CQ. However, the youth team significantly differed from the senior team only in FM. Therefore we consider an assessment of BC as an integral part of predictors of talented youth athletes. The BC profile of Slovak female national volleyball team players (SNT and U17), therefore, confirms the appropriate predispositions of these players for their performance in volleyball. Body composition, however, must be monitored not only selectively, but also continuously. This type of information may allow the coach or the players themselves to identify their physical as well as specific factors affecting sporting performance in volleyball, and in the case of long-term monitoring, it may enhance the choice of adequate training methods and the training load in individual periods of periodized sports training, an adequate supplementation and during convalescence after injuries.

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PROFILI I USPOREDBE SASTAVA TIJELA VRHUNSKIH ODBOJKAŠICA

U ovom radu autori su predstavili profile i usporedbe tjelesnog sastava ženskih slovačkih nacionalnih odbojkaških ekipa (seniorke-SNT, U19 i U17). Sastav je tijela određen pomoću više-frekvencijske metode bioimpedancije (BIA 2000M). Mjereni su parametri uključili količinu nemasne mase tijela (LBM), unutar- (BCM) i izvanstaničnu masu (ECM) te proporciju BCM u LBM (CQ), masu potkožnog masnog tkiva (FM), kutnu fazu koja je upućivala na kvalitetu stanice (α), ukupnu vodu u tijelu (TBW) i njezinu distribuciju u unutar- (ICW) i izvanstaničnoj tekućini (ECW). Zabilježene vrijednosti kod odbojkašica su upućivale na dobro trenažno opterećenje i korespondirale su s vrijednostima koje karakteriziraju vrhunske sportašice čak i u kategoriji U17, budući da su se odbojkašice U17 statistički značajno razlikovale od seniorki samo u masi potkožnog masnog tkiva (p<.05). Naprotiv, statistički značajne razlike između odbojkašica U19 i seniorki utvrđene su u FM, TBW, α, BCM, ECM/BCM, ICW, ECW i CQ (p<.05). Pretpostavka je autora da pokazatelji sastava tijela pojedine ekipe nisu povezani samo s trenažnim opterećenjem kojem su podvrgnute, odnosno razini kondicijske pripremljenosti igračica, već također i s uspješnošću ekipe na važnim natjecanjima.

Ključne riječi: *nemasne masa tijela, masa potkožnog masnog tkiva, elitni sport, analiza bioelektričnom impedancijom*

Submitted: December 15, 2008
Accepted: January 18, 2010

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Acknowledgement

This project was supported by MSM 0021620864 and GAČR 406/08/1514