

ASSESSMENT OF NUTRITION, SUPPLEMENTATION AND BODY COMPOSITION PARAMETERS ON THE EXAMPLE OF PROFESSIONAL VOLLEYBALL PLAYERS

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ABSTRACT

Background. Volleyball is a team game belonging to a group of sports disciplines that involve indirect fighting. Adequate energy coverage in athletes is a crucial issue. It depends primarily on the type, intensity and duration of physical activity related to the sports discipline practiced and to the training cycle duration. The average energy requirement in sportsmen is 50% higher than that of adults.

Objective. The aim of the study was to characterize the mode of nutrition, including dietary supplements and to assess somatic indices in female volleyball players of the AZS Białystok team.

Material and methods. The study involved 17 women. Research tools included a questionnaire consisting of 24-hour recall, a questionnaire survey concerning supplement intake and body composition analysis performed using a bioimpedance analyzer InBody 220.

Results. Data analysis indicates that the anthropometric characteristics and body composition of the AZS Białystok players meet the recommendations associated with the somatic features in volleyball. Daily diet of the volleyball players were of low-energy with regard to the recommendations for physically active people, with very low supply of carbohydrates and dietary fiber, excessive proportion of saturated fatty acids and dietary cholesterol, and too low content of monounsaturated and polyunsaturated fatty acids. Supply of vitamins and minerals was found to be alarmingly low, especially of iron and calcium; diet supplementation was insufficient. No significant abnormalities were noted in body composition of the study athletes. However, they are recommended to increase muscle mass and slightly reduce body fat.

Conclusions. Results of diet evaluation show the need for education in the field of nutrition and the necessity of further research into dietary habits among sportsmen.

Key words: *nutrition, volleyball, dietary supplements, body composition analysis*

STRESZCZENIE

Wprowadzenie. Piłka siatkowa jest grą zespołowego współdziałania, z grupy dyscyplin sportowych o charakterze walki pośredniej. Odpowiednie pokrycie zapotrzebowania energetycznego sportowców jest bardzo istotne. Zależy ono przede wszystkim od rodzaju, intensywności i czasu trwania aktywności fizycznej, związanej z uprawianą dyscypliną sportu i okresem cyklu treningowego. Średnie zapotrzebowanie energetyczne sportowców jest o 50% większe niż osób dorosłych.

Cel. Celem niniejszej pracy była charakterystyka sposobu żywienia z uwzględnieniem suplementacji diety oraz ocena wskaźników somatycznych grupy zawodniczek klubu siatkarskiego AZS Białystok.

Materialy i metody. Badaniem objęto 17 kobiet. Narzędziami badawczymi był kwestionariusz ankiety składający się z wywiadu 24 godzinnego oraz kwestionariusz ankiety dotyczący spożywanych suplementów, a także wyniki analizy składu ciała wykonane metodą bioimpedancji elektrycznej z wykorzystaniem analizatora InBody 220.

Wyniki. Analiza uzyskanych danych wykazała, że cechy antropometryczne i skład ciała zawodniczek AZS Białystok jest zgodny z zaleceniami dotyczącymi cech somatycznych w siatkówce. Stwierdzono, że codzienne racje pokarmowe badanych zawodniczek były niskoenergetyczne w stosunku do zaleceń dla osób aktywnych fizycznie, ze zbyt niską podażą węglowodanów oraz błonnika pokarmowego, a także ze zbyt wysokim udziałem nasyconych kwasów tłuszczowych i cholesterolu pokarmowego, a zbyt niskim jednonienasyconych i wielonienasyconych kwasów tłuszczowych. Wykazano niepokojąco niską podaż witamin i składników mineralnych, w szczególności żelaza i wapnia oraz niewystarczającą suplementację diet badanych siatkarek. Nie stwierdzono istotnych nieprawidłowości w składzie ciała badanych zawodniczek. Zaleca się jednak dążenie do zwiększenia masy mięśniowej oraz nieznacznej redukcji zawartości tkanki tłuszczowej.

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Wnioski. Wyniki oceny jadłospisów wskazują na potrzebę edukacji żywieniowej badanych kobiet oraz konieczność dalszych badań nad oceną żywienia sportowców.

Słowa kluczowe: *żywnienie, siatkówka, suplementy diety, analiza składu ciała*

INTRODUCTION

Volleyball is a team game belonging to a group of sports disciplines that involve indirect fighting. The time of each match is indefinite; there is a specific scoring system, limited contact with the ball and rotations in positions. It is an interval game, classified as a technical game, and in terms of motoric features belongs to a group of strength and speed sports [31].

Adequate energy coverage in athletes is a crucial issue. It depends primarily on the type, intensity and duration of physical activity related to the sports discipline practiced and to the training cycle duration. The average energy requirement in sportsmen is 50% higher than that of adults.

The vast majority of sports disciplines (including team sports) are characterized by submaximum and maximum intensity of physical efforts, both of training and startup. In this case, the source of energy is almost always carbohydrates, while the ultimate nature of glycogen transformation (aerobic and anaerobic) is determined by the intensity and duration of physical activity, and the degree of fitness of the player [3].

The aim of the study was to assess nutrition, supplementation and body composition parameters in professional female volleyball players.

MATERIALS AND METHODS

The study involved 17 professional volleyball players aged 16-36 years. Training schedule set by the trainer and adjusted to the period of training and startup was applied. Table 1 shows training frequency of the study group. All the players in the team practiced at the same times. Training I (main) took place in the sports hall, whereas training II in a fitness club. The average training time during the entire week was 15.5 hours.

Table 1. The frequency of trainings in the study group

	Training I	Training I duration	Training II	Training II duration
Monday		2.5h	-	
Tuesday		1.5h		2.5 h
Wednesday		2.5 h	-	
Thursday		1.5 h		2.5 h
Friday		2.5 h	-	
Saturday	-		-	
Sunday	-		-	

The study involved assessment of nutrition and dietary supplements, as well as body composition. The first part of the questionnaire was based on the evaluation of dietary habits and the composition of daily food intake [29]. In the second part, data referred to dietary supplements using the method of the respondents. Body composition analysis was performed using In Body 220 (Firma Biospace). Bioelectrical impedance is a noninvasive method of measuring body composition

The analyzer determines the following parameters of body composition: TBW – Total Body Water (kg), Protein Mass (kg), Mineral Mass (kg), Fat Free Mass (kg), Body Fat Mass (kg), Body Mass (kg), Skeletal Muscle Mass (kg), BMI – Body Mass Index, Percentage of Body Fat, Waist- hip ratio (WHR), Weight Control (kg), Fat Control (kg), Muscle Control (kg), Fitness Score and Basal Metabolic Rate (kcal).

The basis of bioelectrical impedance analysis (BIA) is the use of knowledge about the human body. It consists of conductors and nonconductors. 50-70% of the human body is water, which is a conductor and fat tissue – nonconductors. The basic principle of body composition analyzer InBody220 is to determine the water content in the body and electrolytes using impedance. The water content allows determining free fat mass. Fat mass is calculated by subtracting FFM from the total body weight [8].

The questionnaire survey and analysis of dietary supplementation were performed once at the beginning of the preparatory season. Questionnaires were created in the Department of Dietetics and Clinical Nutrition on Medical University in Białystok. Nutrition standards introduced by Jarosz [15] were applied. The analysis of body composition performed with bioelectrical impedance was conducted three times: at the beginning of the preparatory season, in the early season and at the end of the first round of matches.

Microsoft Excel spreadsheet by Microsoft(R) Office 2003 was used for data collection. Statistical analyzes were performed using Statistica 7.1 PL. The basic descriptive statistics was performed, including means (M), standard deviations (SD), and level of significance of the difference between the respective parameters determined by body composition analysis. The probability values of $p < 0.05$ were considered statistically significant.

RESULTS

Training frequency and duration of each session can affect the variability of body composition. Anthropometric indices of the women are shown in Table 2. The mean age in the study group was 24.8 years; the average height was 180 cm. The mean body weight in subsequent studies was: 74.7, 74.4 and 73.9 kg, respectively. The average BMI values across the group in subsequent studies were 22 kg/m², 21.9 kg/m², 21.8 kg/m², respectively. The average WHR indicator in subsequent measurements was: 0.82, 0.83 and 0.84.

Table 2. Anthropometric indices of the study group

Parameters	No. of valid	Mean ± SD	Range
Age	17	24.8 ± 5.00	16.0 – 36.0
Height (cm)	17	180.0 ± 10.00	168.0 – 196.0
Body weight 1 (kg)	17	74.7 ± 9.00	59.6 – 94.4
Body weight 2 (kg)	17	74.4 ± 8.70	57.4 – 91.0
Body weight 3 (kg)	17	73.9 ± 8.80	55.7 – 89.7
BMI 1 (kg/m ²)	17	22.0 ± 1.70	19.5 – 25.6
BMI 2 (kg/m ²)	17	21.9 ± 1.70	19.3 – 24.9
BMI 3 (kg/m ²)	17	21.8 ± 1.70	19.0 – 24.6
WHR 1	17	0.8 ± 0.04	0.7 – 0.9
WHR 2	17	0.8 ± 0.06	0.7 – 0.9
WHR 3	17	0.8 ± 0.05	0.7 – 0.9

In the prestart period, there was no BMI < 18.5 kg/m². The BMI value of 18.5–24.9 kg/m² was noted in 15 women (88%), whereas above 25 kg/m² in 2 players (12%).

In the second and third studies, reductions were noted in BMI compared to the first one, the differences being 0.11 kg/m² and 0.24 kg/m², respectively; however, they were not statistically significant. BMI in the second and third test was found to be within the normal range (18.5-24.9 kg/m²) in all the women (n = 17).

Results of body composition analysis from three consecutive tests are shown in Table 3.

During subsequent measurements, weight loss was noted in all the women (the difference was not statistically significant). Between the first and second measurement the mean weight loss was 0.3 kg, between

the second and third measurement 0.5 kg, and between first and third measurement 0.8 kg.

Changes in the percentage of body fat (PBF) were also checked in the three training periods. PBF below the recommended level (<17%) was observed in 7 women in the first and third study, and in 6 in the second one. PBF within the recommended standards (17-22%) was noted in 6 volleyball players in the first and third test, whereas in 7 in the second one. The percentage of body fat was higher than the recommended level (>22%) in 4 players in all the studies.

Statistically significant changes were found in body fat mass obtained in the three measurements in different periods of training in AZS Bialystok players. In the second study there was a reduction in body fat mass by 0.6 kg, and in the third by 0.4 kg. Between the first

Table 4. The average intake of energy and nutrients in daily food intake

	Mean N=17	Range	SD	% realization of the standard and recommendations
Energy (kcal)	1909.6	(841-2729.7)	560.1	59.6
Protein (g)	113.5	(50.6-157.9)	28	94.6
Carbohydrates (g)	221.5	(76.3-366.7)	101	46.1
Fat (g)	69.9	(19.8-98)	25.9	78.6
Fiber (g)	19.8	(12-31.8)	5.8	79.2
Water (ml)	2052.8	(1041-3462)	800.4	-
Fe (mg)	12.1	(3.47-20.9)	8.65	67
Ca (mg)	728	(373-1354)	290	72.8
K (mg)	3362.2	(1747-5641)	1611	71.5
Na (mg)	3756.2	(1535-7615)	1823	250
Mg (mg)	320	(140-501)	180	103
Vitamin C (mg)	64	(128-13.9)	50	71
Vitamin B ₁₂ (µg)	5.92	(3.5-8.3)	2.42	246
Folic acid (µg)	239.2	(110.6-569)	128.6	59.8
Riboflavin (µg)	2.38	(0.17-6.2)	2.1	2.16
Vitamin D (µg)	6.39	(2-11.2)	4.39	127.8
Vitamin E (mg)	8.78	(3.48-16.2)	5.3	109.7
% energy from protein	21.3	(16-33.6)	6.3	-
% energy from carbohydrates	45.9	(919.8-68.8)	15	-
% energy from fat	32.8	(17.7-51.5)	10	-

Table 3. Analysis of body composition in 3 studies

Parameters	Study 1 Mean (range) N=17	Study 2 Mean (range) N=17	Study 3 Mean (range) N=17
Body weight (kg)	74.7 (59.6 – 94.4)	74.4 (57.4 – 91.0)	73.9 (55.7 – 89.7)
Protein (kg)	11.9 (10.0 – 13.6)	12.1 (10.0 – 13.4)	12.0 (10.0 – 13.6)
Minerals (kg)	4.4 (3.5 – 5.1)	4.4 (3.4 – 5.0)	4.32 (3.5 – 5.1)
Fat mass (kg)	14.3 (7.0 – 25.9)	13.7 (6.9 – 19.8)	13.3 (7.0 – 23.4)
Muscle mass (kg)	34.0 (28.2 – 38.0)	38.1 (29.3 – 39.3)	36.9 (27.2 – 38.5)
Adipose tissue (%)	18.5 (11.2 – 29.2)	18.1 (11.4 – 25.3)	17.7 (12.0 – 26.1)
PPM (kcal)	1670.7 (1476.0 – 1850.0)	1691.0 (1462.0 – 1829.0)	1735.5 (1486.0 – 1850.0)

*statistically significant differences

and third study, a 1 kg decrease was noted on average in body fat mass.

A quantitative dietary assessment was also performed. The energy rate of daily food intake was 1909.6 ± 560 kcal on average, accounting for 59.6% of the standard daily energy intake, whereas calorie deficiency fluctuated around 1290 kcal with regard to the recommended norms (3200 kcal). The average intake of energy and nutrients in daily food intake is shown in Table 4.

We found that the mean dietary intake of total protein was 113.5 ± 28 g, mean fat content 69.9 ± 25.9 g, carbohydrates 221.5 ± 101 g, fiber 19.8 ± 5.8 g and water 2052.8 ± 800 ml. The minimum water supply was 1041 ml, whereas the maximum 3462 ml.

The mean dietary intake of fatty acids is shown in Table 5.

Table 5. The mean intake of fatty acids and cholesterol.

	Mean N = 17	Range (min.–max.)	SD
Total fat (g)	69.9	(19.8–98,0)	25.9
Saturated fatty acids (g)	36.6	(3.9–50.71)	14.1
Monounsaturated fatty acids (g)	22.2	(2.7–48.3)	19.9
Polyunsaturated fatty acids (g)	6.0	(1.9–16.3)	4.8
Cholesterol (mg)	390.6	(125.8–773.2)	243.2

Accurate distribution of meals throughout the day is essential for proper functioning of the body. In the study group, one person had only two meals a day, six athletes had 3 meals, six women consumed 4 meals, and five had 5 meals per day. A total of 94% of the study group consumed at least three meals a day. Breakfast consumption was declared by 100% of the respondents.

Dietary supplementation was also analyzed in the study group. The use of isotonic drinks was declared by 13 athletes and regular use of supplements designed for sportspersons was declared by 12; irregular intake was reported by three women, while two respondents denied supplementation.

The assessment also referred to the most frequently consumed type of supplements designed for athletes. It was found that 71% of the study women regularly used protein rich supplements (> 80% protein), 24% used carbohydrates i.e. the so called “carbs”. The use of protein-carbohydrate nutrients, as well as carbohydrate-protein supplements of “gainer” type was noted in 6% of the respondents. Consumption of vitamin and mineral supplements was declared by 71% of the volleyball players. All the athletes admitted their intake only in autumn and winter. The supplements that were consumed to improve efficiency and strength included branched chain amino acids (BCAA; consumed by 12% of the women surveyed), sets of amino acids (76%), creatine supplementation (12%) and glutamine (1 person; 6%).

The consumption of energizing supplements was declared by 47% of the respondents. The most commonly used stimulants in the study group were: caffeine (65%), caffeine tablets (41%); more rarely energy bars (24%) and guarana (8%).

The use of slimming supplements was declared by 47% of the women surveyed. The most frequently consumed supplement was L-carnitine (35% of the respondents); the consumption of chromium, CLA and green tea extract was reported by 18% and HCA by 6% of the respondents.

DISCUSSION

For a long time, coaches and trainers have been looking for factors that determine high sports achievements in volleyball. As a result of many scientific observations, a fitness model of high quality volleyball athletes has been formulated. The somatic determinants for a volleyball champion include: above-average body height, slim figure and a considerable length of limbs [16].

A substantial impact of physiological factors on the general level of physical preparation of young volleyball players has been shown by *Stamm* et al. [26], who analyzed their influence on sports results using seven objective tests. The results of all the tests showed a close correlation with anthropometric characteristics.

Body composition as a predisposing factor has been considered in *Melrose* study. The ideal physiological profile of a volleyball player, which can facilitate the assessment of normal weight and somatic type, is an important factor in achieving high performance in sports [4, 24]. In addition, information on body composition indicates nutritional habits of the player and provides information about body homeostasis [3]. The knowledge of body weight and its individual components can be used as guidance for trainers to make adjustments in the diets of athletes [13].

Body composition of highly skilled athletes should differ significantly from that of the general population, even when compared with people who practice sports recreationally. The highest quality athletes have an increased percentage of lean muscle mass and lower percentage of inactive mass (fat) [21].

During tournaments, players of two female volleyball teams often compete for the ball over the net, which is suspended 2.24 meters above the ground. In the current study, the mean body height was 180 ± 10 cm, being higher than the average body height of the first league female volleyball players from Greece - 176.1 cm [13], Japan - 168.7 cm [32] and India - 159.67 cm [17]. A similar average body height was noted in Spanish volleyball players - 179.7 cm [12], American - 177.9

cm [5], and Brazilian ones - 174.4 cm [1]. Higher body height was reported in the Polish athletes from "Gedania" club in Gdańsk - 182.7 cm [27], and in players from Czech Republic - 184 cm [22].

Currently, the most common method used to assess nutritional status is by means of Body Mass Index (BMI), which is easily available and simple. However, BMI takes into account only the total body weight, without identifying its components, such as muscle and bone tissue, fat tissue and body fluids. This method does not distinguish between the somatic types. In the present study, according to BMI, the players were not overweight and showed no risk of obesity (only in two athletes slight excess was reported), 88% of the study players was well nourished. Some sources show a strong correlation between BMI and body fat [4].

In the current study, the average content of body fat was 18.5%. The result is satisfactory, since the values obtained are similar to those of high performance athletes from other countries. According to literature data, the national elite athletes from Czech Republic showed the lowest percentage of body fat (15.9%) [22]. However, a similar PBF compared to the current results was observed in the university volleyball team surveyed by *Tsunawake et al.* (18.4%) [32]. A much higher percentage of body fat was found in the volleyball team examined by *Abreu de Almeida et al.* (20.5%) [1], *Melrose et al.* (21%) [24], *Malosauris et al.* (22.7%) [21], *Kreger et al.* (22.92%) [18] and *Frasson et al.* (24.93%) [11].

In our study, the average content of muscle mass was 34.3 kg, 38.1 kg and 37 kg in consecutive measurements, accounting for 45.5%, 51.2%, 50% of the total body weight, respectively. Similar values of body muscle mass were observed in volleyball athletes from the United States - 33 kg [30]. However, much higher values were reported from Greece - 46.7 kg [13] and Czech Republic - 55.8 kg [22].

In the present study, no significant changes were found in the BMI from the three training periods. Worthy of note is that at the beginning of the season BMI indicating overweight was noted in two volleyball players. However, in the third study, all the athletes met weight standards. Changes in body mass were not statistically significant (mean 0.8 kg).

Changes in adipose tissue turned out to be satisfactory. The average decrease in body fat was 1.0 kg (approximately 7% from the beginning of the season). The most substantial decrease recorded was 2.5 kg. Similar results were obtained by *Gonzales-Rave et al.* [12]. We found that the decrease in fat mass between the first and third test was accompanied by an increase in muscle mass by 2.7 kg on average (i.e. about 4.5% of total body weight). There is no doubt that the quality and quantity of food and drinks consumed by athletes have a significant impact on their athletic performance.

Studies conducted among young female athletes have shown that the average consumption of energy, vitamins and minerals is too low in relation to the increased needs of the body [14, 20, 25, 28, 30].

In our study, dietary habits were analyzed on the basis of three-day dietary interview conducted before the training started. The energy value and the content of the daily food intake of protein, fats and carbohydrates, as well as some minerals and vitamins, fiber, cholesterol and fatty acids were estimated. Our findings indicate that female volleyball players do not fully implement the recommendations for rational nutrition. The energy provided by daily diet of the surveyed athletes did not meet daily requirements (mean 1909.6 ± 560.1 kcal), covering the demand in 63.6%. Lower energy intake in a daily diet was reported among professional volleyball players from Howard University [30], among leading players of the India volleyball team [14], where the average energy intake was 1471 ± 479 kcal, and among volleyball athletes from Greece - 2013 ± 971 kcal [25]. Insufficient amount of energy in daily diet was also observed in the Greek Super League volleyball team - 2049 ± 735.12 kcal [2]. Not much higher daily energy intake was observed in the elite volleyball players from the USA, with an average of 2248 ± 414 kcal per day; however, the reported value was much lower than that recommended for the group [6].

Energy deficit may have a number of adverse effects. Regular shortage of energy in the diet of an athlete can lead to weight loss, which may involve the risk of muscle mass loss as an undesirable effect of training, and can degrade performance. According to the American Dietetic Association and Medicine in Sports Sciences [6], these ratios should be as high as 12-15% of energy from protein, 25-30% from fats and 55-58% from carbohydrates.

We showed abnormal energy structure of food ration, with too high proportion of fat-derived energy - 32.8% and a very low share of energy from carbohydrates - 45.9%. The share of protein-derived energy was 21.3%, being relatively high. Improperly balanced diet in terms of the content of essential nutrients in the implementation of energy demand was also observed in athletes practicing volleyball in Greece [25], India [14], as well as those in the Polish national team [27].

In volleyball, like in other sports, supply of dietary protein should be considered an important nutritional factor. Protein is an important dietary component among sports professionals - it not only determines body's adaptation to exercise and speed recovery after workout, but is also responsible for proper pace of body's development and its resistance [28]. Energy percentage of daily food ration derived from protein should be about 15%, i.e. an average of 1.2g-1.4 g / kg. mc./ day.

In our study, the average overall protein intake was 113.5 ± 28 g, which covers the demand in 75.7%. Lower intakes were recorded in the Greek volleyball league menus [25], in the 2nd league athletes [30] and in the elite volleyball players in the USA [6]. There was no case where standards for this component were implemented.

Since carbohydrates are the primary energy substrate for working muscles, the recommended share of carbohydrates in daily diet is as high as 60-68% of energy. In the present study, we found much lower share of energy derived from carbohydrates (45.9%), which yielded an average of 221.5 ± 101 grams of carbohydrates a day. Similarly, low scores were noted in female footballers in Greece [25], India [14] and the USA [6].

Such amount of carbohydrates is insufficient for adequate glycogen re-synthesis in female athletes whose stocks are quickly depleted during intense training and competitions. Consequently, the player's efficiency in training or match can be significantly reduced, and may result in an earlier onset of fatigue [28].

In the current study, the amount of dietary fiber was insufficient (mean 19.8 ± 5.8 g). As specified by the World Health Organization, dietary fiber intake should be in the range 27-40g/day. Low fiber intake has been confirmed by many studies carried out in Poland, Greece and the USA [6, 25, 28]. The intake of sucrose was found to be too high (mean 69.5g), accounting for 31% of total carbohydrates.

Fat intake should be at the adequate level in order to ensure delivery of proper amounts of essential unsaturated fatty acids and fat-soluble vitamins, as well as to maintain healthy body weight. We showed that the percentage of fat-derived energy in a daily diet exceeded the norm (30%) and was 32.8%. However, the average dietary fat content was 69.9 g and implemented the standard for this nutrient in 70%. A higher intake of fat was observed in studies concerning Greek [25] and India [14] female volleyball players.

In addition, in accordance with the standards of the World Health Organization the intake of the respective fatty acids should cover the following percentages of diet energy: saturated fats 7%, monounsaturated fats 10-15% and polyunsaturated fats 6-10% [15]. In the current study, the consumption of fatty acids in the athletes included 17.23% of saturated, 10.4% of monounsaturated and 3% of polyunsaturated fatty acids.

According to the standards of the Institute of Food and Nutrition, the daily intake of cholesterol is 300 mg [15]. In our study, the mean cholesterol intake was 390.57 mg. Alarming, the intake of dietary fiber, which effectively reduces the level of cholesterol in the blood, was below the standard (19.8 g).

In the diets for athletes, calcium and iron intake is of special importance, as their shortage is very common

and may entail adverse health consequences [2, 28]. Their daily norm coverage was calculated based on the standards established by the Institute of Food and Nutrition [15] for the recommended intake of minerals for physically active individuals. The mean iron content in daily diet was 12.1 ± 8.65 mg, which accounts for only about 40% of the minimum implementation (importantly, the absorption of this element is relatively low). The mean dietary calcium content was 728 ± 290 mg (33% of standard implementation). The content of vitamins and other micronutrients in the daily diet was below the recommended intake. Such low content of microelements was observed in daily diet of the elite female volleyball players in India [2, 14]. A higher dietary content of vitamins and minerals was observed among Polish athletes residing in Central Sports Centre [2], as well as in Greek female volleyball players [25].

The mean sodium intake in the diets was found to be 3756.2 mg and the maximum amount of sodium was 7615 mg, accounting for 508% of the norm for the ingredient.

In our study, the average fluid intake was 2052.8 ± 800.4 ml. This value is only slightly lower than is recommended (covers 80% of standard implementation); however, it should be remembered that the athlete's body has to make up for fluid loss during exercise to avoid a drop in performance and concentration. Dehydration increases body's fatigue, which results from increased glycogenolysis.

When meals are regularly distributed throughout the day, nutrients can be used properly. The current study took into consideration the number of consumed meals. The standard specifies that a well-planned menu should include 4-5 meals per day, which in the analyzed diets was admitted by about 60% of the players. Similar results were obtained in a survey of female students of Academy of Physical Activity (AWF) in Olsztyn and Warsaw in 2002 (62%) [33]. Significantly lower values were obtained in a study concerning Polish professional volleyball athletes, where the consumption of 4-5 meals was declared by only 17.4% of the respondents [10] and in a study from Podkarpackie Province concerning athletics, where 4-5 meals were consumed by 44% of women [9].

Isotonic drinks are designed to adjust the levels of water and electrolytes excreted from the body in the process of perspiration, and to supplement vitamins, minerals and small amounts of carbohydrates to allow re-synthesis of glycogen, which decreases during exercise. The assessment of eating behaviors showed that 76% of the volleyball players supplemented fluids with isotonic drinks. This result is satisfactory, taking into account the fact that the diet of the female athletes studied did not include enough fluids.

Food components contained in nutrients and supplements positively influence the process of muscle protein recovery, as well as energy processes. Supplementing the diet with nutrient concentrates can enhance the anabolic processes of regeneration, provide enough energy for exercises and protect muscle proteins from degradation.

The surveyed athletes supplemented their diets with different formulations. The use of sports supplements was declared by 89% of the respondents. The most popular nutrients included high protein supplement (71%) and nutrient carbohydrate (24%). Vitamin and mineral supplements were shown to be used by 82% of the players daily or periodically. Lower intake of such supplements was noted in volleyball players from Krakow [10].

Creatine, which is the most studied supplement, was used by our two volleyball players. The role of creatine is to increase the concentration of phosphocreatine in the muscle cells, leading to the acceleration of ATP re-synthesis rate. This process delays the onset of fatigue and facilitates restoration process during repetition of series of high-intensity exercises [23]. Administration of creatine also has a beneficial effect on lean body mass gain, increasing both absolute and relative anaerobic strength [19].

In our study, the most frequently consumed supplements included preparations containing the entire set of amino acids (76%) and stimulants (47%), including coffee (65%) and caffeine tablets (41%). The players also consumed BCAA branched amino acids, creatine, glutamine and slimming preparations (L-carnitine, chromium, CLA, green tea).

CONCLUSIONS

1. Daily diet of the volleyball players were of low-energy with regard to the recommendations for physically active people, with very low supply of carbohydrates and dietary fiber, excessive proportion of saturated fatty acids and dietary cholesterol, and too low content of monounsaturated and polyunsaturated fatty acids.
2. Supply of vitamins and minerals was found to be alarmingly low, especially of iron and calcium; diet supplementation was insufficient.
3. No significant abnormalities were noted in body composition of the study athletes. However, they are recommended to increase muscle mass and slightly reduce body fat.

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