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Original Article

Influence of basketball training on the features of women's physique

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Abstract:
High levels of physical loadings in modern women's sports increase the demands to the organism of athletes. In order to achieve high sports results, and at the same time to improve women's health, it is necessary to deepen the research of morphological and functional features of an athlete's body. The subjects of our research were 12 female basketball players with more than 5 years sports experience. The aim of the study was to analyze their characteristics of physical development. We found that the body height of the basketball players can be estimated as high for the forwards (more than 97 centiles), and average and higher than the average for the defenders (within 50-75 or 75-90 centiles). The body weight exceeds the 75 centile interval (higher than average for healthy people of the corresponding age). The longitudinal dimensions were dominant in the proportions of the body of basketball players, shoulders and pelvis are narrow. The thorax was narrow but the respiratory muscles are well developed. We found that the body proportions of players can be classified as dolihomorph by P. N. Bashkirov, but predominantly with not long hands. According to V.V. Bunak they were theinoid (long). The male type of proportions was indicated by indices of sexual dimorphism. The muscular component of the body of players was well developed, while the bone component was the same, and the body fat was less than that of untrained women. We have determined that the endomorphic component prevails in the constitution of basketball players, mesomorphy and ectomorphy are less significant. Average somatotype of athletes was estimated as balanced endomorph - 4.9-3.2-2.9. Thus, it was found that basketball can be recommended to increase the level of physical development of girls. The obtained results describe the morphological portrait of the basketball player and can be used both during sports selection and in the training process.
Key words: physical development, body composition, body proportions, somatotype.

Introduction

The functional state of the athlete's body is the basis for the implementation of technical and tactical skills, and its analysis has a leading role in the comprehensive assessment of the athlete's fitness. As well as indicators of functional readiness, biochemical status and physical capacity, anthropometric indices are accurate in description of morphofunctional changes in the body of the athlete depending on the type of muscular activity and can be used under the prognostic and preventive purpose. In the recent studies the research team of our department has analyzed the anthropometric data, body composition, indicators of physical development, body proportions and somatotype of female athletes in more than 12 different sports (Vovkanych et al., 2015; Hrynkiv et al., 2013; Kutseryb et al., 2014; Kutseryb et al., 2015). However, even more attention should be paid to the peculiarities of the athlete's morphological characteristics, because, to a large extent, they determine the organism response to physical activity, and play an important role in sports selection. Most literary sources are devoted to the psychological and social aspects of women's sport. Some publications cover the psychophysiological capabilities of qualified basketball players and the problem of restoring their physical capacity. Only small number of studies reflects the peculiarities of the physique of qualified female athletes (Martirosov, 1982; Martirosov et al., 2002; Tóth et al., 2014).

Knowledge of morphofunctional peculiarities of the athlete's body will enable the coach to provide an individual approach to athletes training both during the regular sessions, and in pre-competitive and competitive periods. The **aim** of the present study was to examine the body composition, physical development, body proportions and somatotype of female basketball players on the basis of morphological characteristics of their body.

Material & methods

Participants were 12 female athletes aged from 18 to 21 years with sport experience of at least 5 years (detailed description is provided in Table 1). Before the beginning of the research informed consent was

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obtained. All studies were accorded with the ethical standards declared in the state documents and the internal regulations of the organizations responsible for the study with the participation of a human, as well as the principles of the declaration of the World Medical Association of Helsinki.

The following anthropometric indices were measured: body weight and height (by anthropometer), thickness of skinfolds (by Skinfold Caliper Baseline), longitudinal dimensions of the body, girths and breadths (Sterkowicz-Przybycień et al., 2011; Tzarova, 2013). The composition of the body was calculated by anthropometric method (according to the formulas of Matějka) and by the bioimpedance method (Tanita 400, Tanita BC 601).

Physical development and body proportions were estimated by the index method. One of the most widely used in modern scientific studies was the scheme of somatotyping by Heath-Carter, recommended for persons of both sexes aged from 14 to 70 years, and for the athletes. Somatotypes were estimated using the Heath-Carter anthropometric method by means of equations (Carter & Heath, 1990, 2005). All measurements were performed on the right side of the body, according to the approaches described in the recommendations of Carter & Heath (Carter & Heath, 1990, 2005). Calculations of the somatotype components and the determination of somatotype groups were performed by J. E. L. Carter (2005). The data was analyzed in Microsoft Excel 2010. All values are given as mean ± SEM (standard error of the mean).

Table 1. The description of the female basketball players (n = 12)

No	Playing role	Sport experience, years	Age, years	Body height, cm	Weight, kg	Chest girth (rest), cm	Chest excursion, cm	Body mass index (BMI)	Index of muscles development	Brugsch index
1	Forward	5	18	180.8	63.5	85.1	6.0	19.4	7.7	47.1
2	Forward	11	21	179.0	68.2	88.0	6.0	21.3	3.4	49.2
3	Forward	8	20	165.4	60.8	87.2	5.0	21.5	5.8	49.5
4	Small Forward	13	20	182.0	76.6	88.4	4.7	23.1	2.0	48.6
5	Small Forward	6	19	167.1	76.6	80.5	6.1	21.6	3.9	46.8
6	Small Forward	7	20	182.0	63.1	86.2	2.6	21.8	4.7	47.8
7	Defender	6	18	167.1	60.0	79.5	9.9	21.5	4.0	47.6
8	Defender	5	19	164.1	57.0	86.2	4.0	21.2	5.6	52.5
9	Defender	8	20	171.7	58.5	80.6	7.2	19.8	9.5	46.9
10	Defender	11	24	161.0	60.8	89.0	4.1	23.5	9.4	55.3
11	Point guard	10	20	165.4	63.1	83.5	6.1	22.1	4.9	50.2
12	Point guard	5	20	180.8	60.0	84.9	5.9	21.2	5.1	49.6

Results

The average age of basketball players was 20 years. Analysis of the body height of athletes showed the highest values for the forwards (179 – 182 cm) and significantly lower values for the defenders (161– 171.7 cm). These values are in good agreement with data of E. G. Martirosov (1998) obtained for qualified athletes, according to which the body height of the forwards was 180.3 ± 5.0 cm and defenders - 170.4 ± 3.8 cm (Martirosov, 1998). The body height of the examined basketball players can be estimated as high for the forwards (more than 97th centiles for the average height of 18-20 years girls) and average (from 161 to 167 cm, within 75th centile) for the defenders (Kuczmarski et al., 2002).

The body weight of the athletes exceeded the 75th centile level, and could be assumed as higher than the average for the corresponding age. However, it was significantly lower than values, obtained by other authors (Martirosov, 1998) for the female forwards (76.6 ± 6.89 kg) and defenders (66.3 ± 4.83 kg).

The chest girth of the examined subjects was 4 cm smaller than the value for highly skilled basketball players (Martirosov, 1998; Tzarova, 2013). The suggestion about insufficient (for their growth) development of the chest of the examined female basketball players was supported by the low levels of the chest-to-height indices (see Table 1).

The values of body mass index (BMI) indicated normal body weight for all athletes (see Table 1). Only for two defenders the chest development, estimated by chest-to-height indices, was normal, for the rest the chest was estimated as narrow, disproportionate to height. However, we suggests that such parameters of the chest, and the predominance of longitudinal body sizes of basketball players, meet the requirements of their sport and displayed the morphological adaptation to the large number of vertical jumping elements during competitive and training activities. At the same time, the values of chest excursion (see Table 1) of our subjects indicated a good development of respiratory muscles, which enabled the high level of respiration effectiveness.

Analysis of longitudinal and transverse dimensions of the body by method of P. N. Bashkirov revealed a large length of the lower extremities for most athletes (Table 2). This is clear from the ratio (55.2 ± 0.49%) between the length of the lower limb and the body height.

The ratio of biacromial breadth to body height was 21.79 ± 0.24%, indicated the narrowest shoulders. The average value of pelvic width index was 15.74 ± 0.21%, the index of body length – 29.66 ± 0.34%, and the index of arm length – 42.12 ± 0.70%.

Most of female basketball players belonged to the dolihomorphic type of proportions with not long hands, as it was found by way of analysis. Proportions of their body were analyzed by the method of P. N. Bashkirov, based on the above-mentioned indices.

According to the classification of V.V.Bunak, which takes into account the length of legs and shoulder width, 75% of the examined players (and all forwards) had theinoid (long) type of body proportions. The proportions of the remaining 25% of the players (and some of the defenders) could be classified as paratheinoid (long legs, middle shoulders) or harmonoid (Table 2). The ratio of biiliocristal breadth to biacromial breadth (less than 79.3%) indicated the male type of body proportions for the majority of the athletes.

Table 2. Body proportions of basketball players (n = 12)

Playing role	Type of the body proportions		
	by P. N. Bashkirov	*by Bunak V.V.*	*by the indices of sexual dimorphism*
Forward	Dolihomorph with middle-length hands	Theinoid	Male
Forward	Dolihomorph with middle-length hands	Theinoid	Male
Forward	Dolihomorph with middle-length hands	Theinoid	Male
Small forward	Dolihomorph with short hands and middle pelvice	Theinoid	Male
Small forward	Dolihomorph short hands and middle pelvice	Theinoid	Male
Small forward	Dolihomorph short hands and middle pelvice	Theinoid	Male
Defender	Dolihomorph short hands and middle pelvice	Theinoid	Male
Defender	Dolihomorph with middle shoulders	Paratheinoid	Middle
Defender	Dolihomorph with short hands	Theinoid	Male
Defender	Dolihomorph with middle shoulders	Paratheinoid	Middle
Point guard	Long trunk, short hands middle pelvice	Theinoid	Male
Point guard	Long trunk, middle legs, short hands, middle shoulders, narrow pelvice	Harmonoid	Male

The analysis of the body composition of female basketball players by bioimpedance method is summarized in Table 3. The absolute weight of dry bone tissue was 2.70 ± 0.26 kg, the relative weight of adipose tissue (fat) – 18.54 ± 3.81%, the level of visceral fat – 1.58 ± 1.66%. Absolute muscle weight was 51.79 ± 6.28 kg. It should be mentioned that bioimpedance analysis determines the total weight of all muscles of the body, including smooth muscles and myocardium.

To clarify the results of the bioimpedance analysis, the composition of the body was also determined by anthropometric (calculation) method according to the anatomical model, which makes it possible to determine the absolute and relative weight of the skeleton and skeletal muscles.

The analysis of the body composition of basketball players by the anthropometric method showed that the absolute weight of the bone component (9.61 ± 0.86 kg) for our subjects was lower than literature data, but the relative weight of the skeleton (15.18 ± 1.10%) corresponded to the normal level for women (15-16%) and was close to the data for basketball players of high qualification (14.7 ± 1.1% for the forwards and 14.5 ± 1.2% for the defenders) obtained by other authors (Tóth et al., 2014). The larger values of the bone component with forwards (11.3 ± 1.0 kg) and smaller with defenders (9.6 ± 0.8 kg) were revealed.

The value of fat component (18.4 ± 3.33%) confirmed the data of bioimpedance measurements, it corresponded to normal levels for women (12-18%) and was slightly lower than that of athletes, examined by other authors (Malinowski & Bozitow, 1997; Carter & Heath, 1990).

The absolute weight of the muscular component in our group (28.68 ± 1.06 kg) was lower than the data of other authors (from 35.7 ± to 30.9± kg, depending on the playing role); while the difference in the values of the relative weight of skeletal muscles (other authors - 46.7 ± 2.9% for the forwards and 46.5 ± 2.7% for defenders) was less noticeable (Tóth et al., 2014). Smaller values of the absolute weight could be explained by smaller body height and less weight of our subjects. Absolute and relative values of the weight of skeletal muscle in our subjects were higher than that of untrained women (Martirosov et al., 2006; Malinowski & Bozitow, 1997).

Table 3. Results of the bioimpedance analysis of the body composition of female basketball players (n = 12)

No	Playing role	Body fat, %	Total muscles, kg	Bone mass, kg	BMI, kg/m^2	Visceral fat level
1	Forward	21.8	49.5	2.6	21.1	1.0
2	Forward	20.4	43.7	2.3	22.3	1.0
3	Forward	22.1	46.8	2.5	22.9	1.0
4	Small Forward	19.6	45.6	2.4	23.8	1.0
5	Small Forward	25.4	40.4	2.2	20.6	2.0
6	Small Forward	15.0	56.0	2.8	20.8	1.0
7	Defender	19.0	55.1	2.9	21.1	1.0
8	Defender	18.2	58.9	2.9	21.3	1.0
9	Defender	12.7	53.6	2.8	20.6	6.0
10	Defender	14.1	54.9	2.9	22.3	1.0
11	Point guard	18.1	61.7	2.9	21.1	2.0
12	Point guard	16.0	55.3	3.2	21.9	1.0

To characterize the development of muscles on different segments of the limbs, the measurements of girths and skinfolds were performed. The fairly large hip girths (for the forwards - 57.0 – 61.9 cm, for the defenders – 53.1 – 57.8 cm) were found, which in combination with small thickness of the subcutaneous fat layer suggests the well-developed hip muscles. The hip girth of our subjects was close to that, obtained by other authors (61.3 ± 3.2 cm for the forwards, 58.7 ± 2.8 cm for the defenders) (Tóth et al., 2014). The girths of the shin of most athletes also corresponded to the average values for basketball players, examined by other authors (Tóth et al., 2014).

There was no clear relationship between the girth of arms and forearms and the playing role of the female basketball players. We found that girths of arm (26.44 ± 0.70 cm) and forearm (23.45 ± 0.59 cm) were somewhat smaller in comparison with the data of other authors, showed a weaker developed of the muscles of upper limbs. According to Martirosov E.G., the average girth of the relaxed shoulder of highly skilled female forwards was 28.5 ± 2.1 cm, of the defenders - 27.4 ± 1.6 cm (Martirosov, 1998). The mean forearm girth of the forwards was 25.8 ± 1.2 cm, defenders - 24,6 ± 0,9 cm (Tóth et al., 2014). The data analysis shows that the girths of the examined players were predominantly larger in forwards and smaller in defenders.

The integral indicator of a person's physique is the constitution or somatotype. Somatotype of athletes was determined according to the scheme of Heath-Carter (Carter & Heath, 1990). Obtained data shows significant individual differences in the values of different components of the constitution of basketball players (Fig. 1).

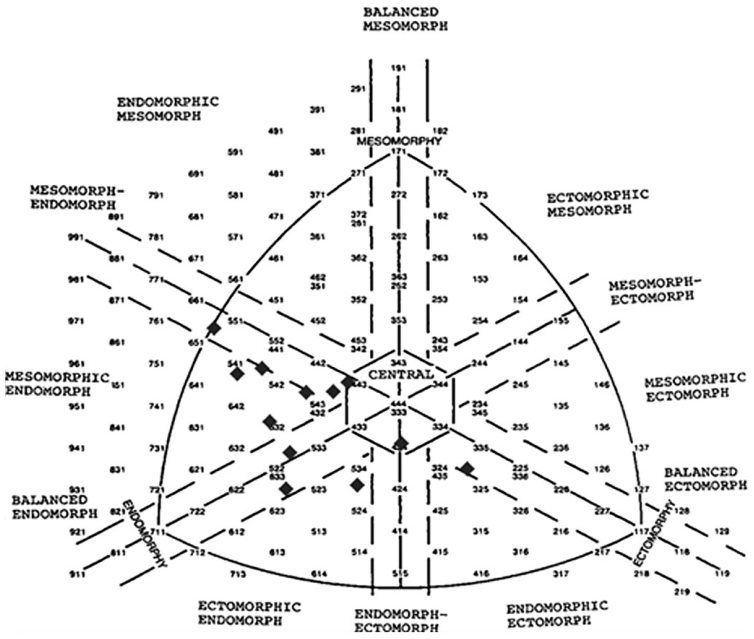

Fig. 1. Somatotypes of female basketball players according to Heath-Carter.

High values of mesomorphy (4.7 – 5.1 units) were found only for two of the examined athletes. In the case of six girls the development of the skeleton and skeletal muscles corresponded to the mean value of mesomorphy – from 3.4 to 4.1 units. For the rest players the mesomorphic component was estimated at the level of 2.2 – 2.7 units.

The endomorphy dominated in the group of female basketball players. It is important to note the domination of the mesomorphic component and more pronounced ectomorphy in case of male players in comparison to the female ones. As we had shown, the average somatotype of male basketball player was 3.10-4.67-4.36 (mesomorph-ectomorph); of volleyball player – 3.09-4.54-3.08 (balanced mesomorph); tennis player – 3.60-4.62-3.27 (balanced mesomorph); soccer player – 3.75-4.34-3.16 (endomorphic mesomorph) (Vovkanych et al., 2015; Hrynkiv et al, 2013; Kutseryb et. al, 2014; Kutseryb et. al, 2015; Martirosov, 1982; Martirosov, 1998; Raschka & Schmidt, 2013; Ramirez-Velez et al., 2014; Kutseryb, 2017).

Discussion

The anthropometrical measurements showed that the average body height of the female basketball players was 171.4 ± 8.23 cm and could be interpreted as higher than average in comparison with the average height of girls of the same age. Body height of five athletes could be estimated as high (from 179.0 to 182.0 cm). According to L. Sergienko and V. Starosty (1998), the development of body height during ontogenesis is by 72-97% determined by inheritance factors, but during puberty (girls aged 10-12 years), hereditary control on the growth is reduced. Taking into account the sports experience of the surveyed, it is obvious that basketball training took place in their early adolescence. Consequently, it can be assumed that the height of athletes was the result of both influence of hereditary factors and training loads.

Comparison of total and partial dimensions of athletes' bodies shows the prevalence of longitudinal dimensions over transverse ones, pronounced elongation and slenderness of the body, which made it possible to attribute most of the athlets to dolihomorph (according to P. N. Bashkirov) or theinoid (according to V.V. Bunak) types of body proportions. Obviously, the training process of the subjects did not lead to the increased development of muscles of the trunk and upper limbs, but nevertheless caused a relatively larger biacromial and smaller biiliocristal breadth, indicating the male type of stature.

The body weight of our subjects was above the average according to the centile scale for the body weight of the untrained girls, but some authors reported even higher values for the body weight of highly skilled basketball players. At the same time, the BMI values of the subjects did not support the suggestion of their excess weight.

The well developed skeletal muscles (45.19 ± 2.17%) and medium level of body fat (18.4 ± 3.33% of total body weight) was shown. Despite much lower values of the relative weight of the fat component, revealed for the skilled athletes of many other sports, our data, especially the level of visceral fat, can be estimated as positive trend for the fitness and health of female athletes. Thus, presence of a sufficient amount of adipose tissue in lesser and greater amentum and in adipose capsule of the kidneys ensures proper fixation of internal organs and cushioning of the impulses during the run and especially during jumps that are regular in basketball.

The skeletal muscles development is definitely the result of their hypertrophy under the influence of physical loads. The analysis of the body girths of our subjects indicates the most pronounced development of the muscles of lower limbs, especially the muscles of the hip, which are involved in the takeoff phase of vertical jumps.

An important indicator of the level of physical development is the chest girths. In most of the subjects the chest was narrow and did not burden the body during jumps. However, the magnitude of the chest excursion indicates a good development of the respiratory muscles, which increase the athlets' ability to perform long training and competitive loads.

The analysis of the somatotype as the integral indicator of the body physique did not show the large values of the ectomorphic component (average value – 2.9). Obviously, this is due to the fact that ectomorphy estimation is based on the weight-to-height ratio. In our subjects this value was normal (based on BMI) or even higher than normal level (based on centile method), despite the theinoid (long) type of somatotype. The values of the mesomorph component (3.2) and endomorphy (4.9) are higher than ectomorphy, confirming the peculiarities of body composition of the subjects we have found, in particular the level of development of muscle and fat components.

Conclusions

The obtained values of the body height of female basketball players were high for the forwards (from 179 to 182 cm) and average for the defenders (from 161 to 171.7 cm), they consist with data of other authors for skilled athletes of the corresponding sport. The body weight can be estimated as higher than average for the corresponding age, while a low fat content and good muscle development of the subjects is found.

The longitudinal dimensions dominated in the proportions of the body of female basketball players, their shoulders, pelvis and thorax were narrow. It can be explained as the manifestation of the adaptation to vertical jumps that dominate the training process of athletes.

The BMI value (21.60 ± 1.53 kg/m^2) of the subjects indicates the normal body weight. Despite the possible suggestion of poor development of the thorax, based on its dimensions, the value of the chest excursion indicates well developed respiratory muscles, which allows long training and competitive loads.

The following mean values of the relative weight of the main components of the body of athletes have been determined by bioimpedance and anthropometric methods: bone tissue – 15.18%, adipose tissue – 18.4% (visceral fat – 1.58%), skeletal muscles – 45.19%. The development of skeletal muscles in our subjects is greater than with untrained women, but somewhat less than with basketball players of high qualification. The most developed are the muscles of thigh, since these muscles particularly the musculus guadriceps femoris, play an important role in the takeoff phase of jumping.

The endomorphy dominates in the somatotype of the subjects, while mesomorphy and ectomorphy components are less pronounced. The average somatotype is 4.9-3.2-2.9 – balanced endomorph.

Our data allows us to recommend the basketball training for the improvement of the physical development of women. The knowledge of the described in our study morphological features of the female basketball players will facilitate the selection of the players for the basketball section, as well as will improve the individual approach to athletes both during regular training, and in pre-competitive and a main competition periods.

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