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Morphological Profile of Different Types of Top Young Female European Basketball Players

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A B S T R A C T

Basketball is a team sport involving several types of players who differ in terms of body height and other morphological dimensions. This study aimed to establish and analyze the morphological characteristics of top young female European basketball players, the development levels of the morphological characteristics of three basic types of such players and any differences among them. The sample of subjects comprised 115 female basketball players aged 14.64 (±0.48) years. They were divided into three groups according to their playing position: guard (N=51), forward (N=33) and center (N=31). The study applied 23 morphological measures, based on which the somatotype components, percentages of bone, muscle and fat tissue and other morphological indexes were calculated. Statistically significant differences ($p<0.05$) were established between individual types of players in terms of their body height, body mass and the three somatotype components, by using a one-way analysis of variance, whereas no such differences were identified in terms of their bone, muscle and fat tissue percentages. There were no differences even after the effect of body height was eliminated by using a multivariate analysis of covariance. The effect of the covariate was only statistically significant in terms of bone tissue percentage. The results of the study thus refute the assumption that it is possible to differentiate player types according to their proportions of fat and muscle tissue.

***Key words**: basketball, women, anthropometry, playing positions*

Introduction

The study of athletes' anthropometric and/or morphological characteristics contributes significantly to understanding the overall concept of performance in most sports. Basketball is a sport in which morphological characteristics have both strong indirect and direct influences on athletes' performance. This has been confirmed by a series of studies dealing with the morphological characteristics of male and female basketball players of different age groups[8,10–14,20,27,28,33].

Basketball is a sport requiring great body height and other longitudinal dimensions. These dimensions therefore largely differentiate basketball players from non-athletes and also from athletes in most other sports[5]. They mainly influence the efficiency of certain specific basketball movements with a pronounced vertical component (rebound, different shots at the basket, passes, blocking of shots, attempting a jump ball, etc.). Besides the longitudinal dimensions, other morphological ones also affect the efficiency of basketball technical and tactical skills and thus playing performance. Researchers tend to ascribe somewhat less importance to transversal dimensions and volume than to longitudinal dimensions, whereas the impact of subcutaneous fat is negative, predominantly with male and female perimeter players, i.e. guards and forwards[10,13].

The game of basketball involves several types of players; they are divided into guards, forwards and centers. Moreover, players differ in terms of their psychosomatic status dimensions, due to the specific features of each playing role. This also applies to the morphological characteristics of both male[11,14,19,33] and female[2,4,7] basketball players. The most apparent differences are found in longitudinal dimensions; however, to some extent, each type of basketball player has a specific profile of transversal dimensions, circumferences and fat tissue.

In 2008, 2009 and 2010, an international basketball camp for select under-15-year-old European female bas-

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ketball players took place in Postojna, Slovenia. With the prior agreement of FIBA Europe and the Basketball Federation of Slovenia, we took this opportunity to measure morphological characteristics and to establish a morphological profile of the best European female basketball players of this age. A database was created to establish quality international standards for different types of female basketball players of this age category. Although this subject had received much research attention in the past, the literature in effect lacks any studies using a sample of female basketball players of such high quality and of such a young age. The purpose of this study was to enable coaches at various basketball camps and coaches of school, club and primarily national teams to appropriately assess the morphological characteristics of their female basketball players and to compare them against those of top European female basketball players.

Data on the morphological profile of female basketball players of such a high quality are clearly very important and valuable for both basketball theory and practice. Such data enable model values to be generated, which can greatly assist both basketball coaches and basketball researchers.

Subjects and Methods

One hundred-and-fifteen female basketball players aged between 14 and 15 participated in the study. Their average age was 14.64±0.48 ($\overline{X}$±SD) with basketball experience of 5.04±1.92 years. The sample of subjects consisted of practically all top female European basketball players of three years (born in 1993, 1994 and 1995) aged up to 15 years. The participants were divided into three groups according to their playing positions: guards: (N=51), forwards (N=33) and centers (N=31). The classification by playing position was made by the coaches, and was officially published by the camp organizers. The subjects came from twenty-eight (28) European countries, which were each represented by between two and six players. As a rule, these were the top players in their countries and members of their national teams, chosen by their national team selectors. They were all tested during three international FIBA camps for the best European U-15 basketball players, held in Postojna, Slovenia. The camps took place from 6 to 11 July 2008, from 5 to 10 July 2009, and from 3 to 8 July 2010. They were organized by the international basketball organization, FIBA Europe, and the Basketball Federation of Slovenia. During the camp, well-known international coaches, i.e. FIBA instructors, trained the players in basketball technique, tactics and conditioning.

The basketball camp was organized at the beginning of school holidays, soon after the basketball club season had finished for most participants (Table 1). The measurements took place on the first day of the camp in order to avoid the influence on the results of the measurements. The measurements were performed within the framework of the camp program, which was prescribed and adopted by the Expert Council of the Basketball Federation of Slovenia and FIBA Europe. Ethics approval for the study was granted by the Committee on Scientific Research of the Faculty of Sport, Ljubljana. For all participants, formal consent was given by their parents/guardian prior to the investigation. All participants were healthy and reported no injuries.

In the study, a battery of 23 standard anthropometrical measures was applied, i.e. indicators of longitudinal and transversal dimensions, circumferences and fat tissue (Table 2). These were applied in the calculation of seven morphological indexes: the three somatotype components (according to the Heath-Carter method[6]), percentages of bone, fat and muscle tissue (according to Matiegka[24] and revisited according to Cattrysse et al.[8]), and body mass index.

The anthropometric measures and the techniques for measuring individual variables complied with the instructions issued by the Australian Sports Commission[26] and the uniform doctrine of the International Biological Program (I.B.P.). The measurements were conducted using instruments designed by Siber Hegner and Co. Ltd., Zurich, Switzerland, as recommended by the I.B.P.

The data were processed using the SPSS 19.0 statistical software for Microsoft Windows. The following descriptive statistics were calculated for all groups of sub-

TABLE 1
AGE AND BASKETBALL EXPERIENCE OF THE SUBJECTS

	Position	$\overline{X}$	SD	Std. error	Min.	Max.
Age (years)	G	14.59	0.548	0.067	14	15
	F	14.68	0.475	0.081	14	15
	C	14.68	0.476	0.090	14	15
	Total	14.64	0.483	0.045	14	15
Basketball experience (years)	G	5.48	1.850	0.252	2	9
	F	4.82	1.882	0.323	1	9
	C	4.46	1.972	0.373	1	9
	Total	5.04	1.922	0.178	1	9

G – guards, F – forwards, C – centres

TABLE 2
DESCRIPTION OF THE SAMPLE OF VARIABLES OF MORPHOLOGICAL MEASURES AND INDEXES*

CODE	Anthropometric measure/dimension
AKGB	Skin fold of upper arm (biceps) (mm)
AKGH	Skin fold of back (mm)
AKGM	Skin fold of calf (mm)
AKGN	Skin fold of upper arm (mm)
AKGP	Skin fold of forearm (mm)
AKGPR	Chest skin fold (mm)
AKGS	Skin fold of thigh (mm)
AKGSI	Suprailiac skin fold (mm)
AKGT	Skin fold of stomach (mm)
AOML	Circumference of calf – left (cm)
AONL	Circumference of upper arm – left (cm)
AONMAXL	Circumference of upper arm – left – max (cm)
AOPL	Circumference of forearm – left (cm)
AOSL	Circumference of thigh – left (cm)
AOSLSR	Circumference of thigh – left – medium (cm)
APKOLL	Diameter of left knee (cm)
APKOML	Diameter of left elbow (cm)
APSSL	Diameter of left ankle joint (cm)
APZL	Diameter of wrist (cm)
ASM	Pelvis width (cm)
ASR	Shoulder width (cm)
BH	Body height (cm)
BW	Body weight (kg)
ECTO	Ectomorphic component of somatotype (Heath-Carter)
ENDO	Endomorphic component of somatotype (Heath-Carter)
MESO	Mesomorphic component of somatotype (Heath-Carter)
BTP	Percentage of bone tissue (Matiegka) (%)
FTP	Percentage of fat tissue (Matiegka) (%)
MTP	Percentage of muscle tissue (Matiegka) (%)
BMI	body mass index (kg/m^2)

* The skin folds, circumferences and diameters of arms and legs are measured on the left side/extremity

jects: mean value, standard deviation, standard error and minimal and maximal results. The differences between the groups (types of players) were established using a one-way ANOVA. Considering that body height was found to be statistically significantly differentiated between player types (as some other authors[3,13,15,16,22,25] also found), the differences in terms of bone, fat and muscle mass percentage were established before and after the elimination (partialisation) of the effect of body height. Therefore, a multivariate analysis of covariance (MANCOVA) with body height as a covariate was additionally conducted for the variables BTP, FTP and MTP; p values <0.05 were considered statistically significant.

Results

First, the selected morphological indexes were calculated for all three groups of subjects; their basic morphological characteristics were established, which was followed by an investigation of the differences between them. The results are shown in Table 3.

Furthermore, we were interested in changes in the bone, fat and muscle mass percentages after eliminating the effect of body height, which statistically significantly differentiates the player types.

Table 4 shows that after the effect of body height had been eliminated (partialization) using a multivariate analysis of covariance, the average percentages of bone, fat and muscle tissue did not change greatly.

Even after eliminating the body height effect, no statistically significant differences were established between the player types in terms of their bone, muscle and fat tissue percentages (Table 5). The effect of the covariate is only statistically significant in terms of the percentage of bone tissue ($p<0.039$) where the intensity of the effect, i.e. the share of explained variance is the highest (Partial Eta Squared=0.039). With the two other dependent variables (FTP, MTP), the intensity of the effect equalled 0.01 or less (Figure 1).

Discussion and Conclusion

From the results presented in Table 3, it can be established that the centres, aged slightly less than 15, in top European national teams are already 183 cm tall on average and thus 7 cm taller than the forwards and 14 cm taller than the guards. Similar results were reported by Erčulj and Bračič[17] in their study of the morphological characteristics of European female basketball players of a similar age, which used a considerably smaller sample. The differences between the types of young female basketball players are statistically significant in terms of body height and weight (Table 3). Other authors have reported similar findings[3,13,22]; however, their samples consisted of slightly older female basketball players. In terms of body mass index (BMI), there were no statistically significant differences between the individual player types.

Regarding somatotype, the guards had all three types (ectomorphic, endomorphic and mesomorphic) in relative balance; the forwards had a slightly more-pronounced endomorphic component and a slightly less-pronounced mesomorphic component, and the centres a more-pronounced ectomorphic and considerably less-pronounced mesomorphic component. Statistically significant differences were established between the player types in terms of all three somatotypes. The most obvious differences between them (F=12.15) were established in terms of the mesomorphic component, mainly because it was less pronounced in the centres. In terms of the ectomorphic and endomorphic components, the centres and forwards dominated, respectively. Using a sample of top senior women's basketball players, Carter et al.[7] established that the mesomorphic component was

TABLE 3
DESCRIPTIVE STATISTICS AND DIFFERENCES BETWEEN TYPES OF PLAYERS

	Position	$\overline{X}$	SD	Std. error	Min.	Max.	F*	Sig*.
BW	G	58.898	6.4385	0.9016	46.0	74.8		
	F	66.200	5.6638	0.9859	55.6	76.9		
	C	71.087	9.4564	1.6984	54.5	96.6		
	Total	64.279	8.7946	0.8201	46.0	96.6	29.398	0.000
BH	G	167.880	5.4780	0.7671	158.0	187.0		
	F	176.188	5.1389	0.8946	165.0	185.6		
	C	183.029	4.0117	0.7205	174.8	191.7		
	Total	174.348	8.0620	0.7518	158.0	191.7	90.706	0.000
BMI	G	20.867	1.8445	0.2583	17.2	26.0		
	F	21.324	1.7656	0.3074	16.8	24.6		
	C	21.177	2.4088	0.4326	17.4	26.5		
	Total	21.082	1.9836	0.1850	16.8	26.5	0.578	0.563
ECTO	G	3.073	0.9886	0.1384	0.9	5.4		
	F	3.361	1.0565	0.1839	1.5	6.3		
	C	3.874	1.1567	0.2078	1.4	5.9		
	Total	3.371	1.0967	0.1023	0.9	6.3	5.566	0.005
ENDO	G	3.431	0.6810	0.0954	2.5	5.7		
	F	3.870	0.7927	0.1380	2.5	5.4		
	C	3.532	0.8886	0.1596	2.1	6.0		
	Total	3.584	0.7889	0.0736	2.1	6.0	3.314	0.040
MESO	G	3.488	0.9182	0.1286	1.5	5.9		
	F	3.018	0.8939	0.1556	0.8	4.8		
	C	2.516	0.7599	0.1365	1.1	4.4		
	Total	3.091	0.9529	0.0889	0.8	5.9	12.160	0.000
BTP	G	16.006	1.3241	0.1854	13.4	19.0		
	F	15.797	1.3653	0.2377	13.5	18.5		
	C	16.226	1.8656	0.3351	13.0	20.5		
	Total	16.005	1.4947	0.1394	13.0	20.5	0.654	0.522
FTP	G	21.886	3.1286	0.4381	16.3	32.5		
	F	23.245	4.4413	0.7731	14.5	31.7		
	C	22.768	5.3762	0.9656	13.0	38.1		
	Total	22.514	4.2172	0.3933	13.0	38.1	1.120	0.330
MTP	G	41.278	2.1481	0.3008	37.2	46.4		
	F	42.100	2.2490	0.3915	38.3	47.0		
	C	41.326	2.4278	0.4360	36.8	47.2		
	Total	41.527	2.2646	0.2112	36.8	47.2	1.499	0.228

* ANOVA; G – guards, F – forwards, C – centres

more pronounced in guards, i.e. the perimeter players. Similarly to our findings, these authors also reported lower values of the ectomorphic component with guards compared to forwards and centers. It is clear that as early as in this age category, the somatotype trends are similar to those of top senior female basketball players. The data on young female basketball players' somatotypes can thus be helpful for selecting players and directing them towards certain playing roles or positions.

With all three player types, one can see very similar and relatively high values of fat tissue (about 22 percent) and skin folds. These correspond to the level established in the general population of girls of this age[18,23,30,32,34]. It is interesting that some other authors[17,22] found that centers are highly predominant in terms of percentage of fat tissue, while also reporting that a slightly higher percentage of fat tissue in young female basketball players does not hinder their performance as centers. In our

TABLE 4
ADJUSTED MEANS OF BTP, FTP AND MTP AFTER MANCOVA (AFTER ELIMINATING THE BODY HEIGHT EFFECT)*

	Guards	Forwards	Centres
BTP	16.381	15.690	15.722
FTP	22.441	23.088	22.024
MTP	41.464	42.047	41.077

* Covariate appearing in the model is evaluated at the value: avg. = 174.348

study, the forwards had a slightly higher percentage of fat tissue than the centers. In our opinion, the smaller share of muscle mass found with the centers is also due to the accelerated growth of the body that is characteristic of this age group[5,23,32] and is, of course, even more prominent with the centers. At the ages of 14 and 15, the rapid physical development that is typical of girls slowly comes to an end[21,23]. Moreover, the percentage of fat tissue in the selected sample of female players was relatively high compared to top senior female basketball players whose values of fat tissue slightly exceeded 15 percent[7,29]. The reasons may possibly be found in the nutrition habits, training experience, age of the subjects and the fact that they are in puberty, and perhaps also in their physical development. At this age, it is often established that their biological physical development even prevails over the effects of training[5]. A higher share of fat tissue is one of the physical changes that characterize the rapid body development of girls in puberty[9]. At this age, girls show less interest in very intensive motor activities such as strength training with weights or endurance training, and achieve worse results in those sports (movements) in which muscle force, strength and velocity play an important role[23]. The three player types are relatively equal in terms of the percentage of bone mass, and this similarly applies to muscle mass, where a slightly

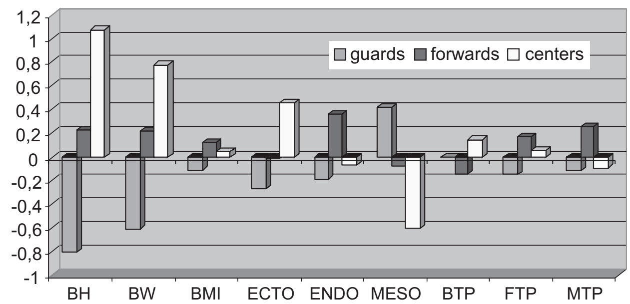

Fig. 1. Comparison between the guards, forwards and centers in standardized Z-scores.

TABLE 5
TESTS OF BETWEEN-SUBJECT EFFECTS

Source	Dependent variable	Type III Sum of squares	df	Mean square	F	Sig.	Partial Eta squared
Corrected model	BTP	12.470[a]	3	4.157	1.905	0.133	0.049
	FTP	60.532[b]	3	20.177	1.139	0.337	0.030
	MTP	17.568[c]	3	5.856	1.146	0.334	0.030
Intercept	BTP	3.091	1	3.091	1.416	0.237	0.013
	FTP	5.248	1	5.248	0.296	0.587	0.003
	MTP	122.146	1	122.146	23.910	0.000	0.177
BH	BTP	9.531	1	9.531	4.368	0.039	0.038
	FTP	20.784	1	20.784	1.173	0.281	0.010
	MTP	2.327	1	2.327	0.456	0.501	0.004
Playing position	BTP	6.480	2	3.240	1.485	0.231	0.026
	FTP	17.874	2	8.937	0.504	0.605	0.009
	MTP	14.779	2	7.389	1.446	0.240	0.025
Error	BTP	242.207	111	2.182			
	FTP	1966.926	111	17.720			
	MTP	567.058	111	5.109			
Total	BTP	29713.880	115				
	FTP	60318.230	115				
	MTP	198900.760	115				
Corrected total	BTP	254.677	114				
	FTP	2027.458	114				
	MTP	584.626	114				

a. R Squared = 0.049 (Adjusted R Squared = 0.023); b. R Squared = 0.030 (Adjusted R Squared = 0.004); c. R Squared = 0.030 (Adjusted R Squared = 0.004) higher percentage was recorded with the forwards. Surprisingly, the lowest percentage of muscle tissue was measured with the guards, and it is their development of motor abilities that researchers have often found to be at the lowest level[1,13,31]. When speaking about the bone and muscle tissue of athletes in adolescence, it is quite difficult to separate the effects of biological growth from those of training[5]. Researchers have established that rapid physical development (skeletal and sexual) is characteristic of successful young female and male athletes aged between 11 and 16[23], and that systematic training causes specific changes and differences between different groups of athletes only after this period, i.e. after the period of growth and development has been completed[5].

Considering the fact that we found, as some other authors[3,13,16,22] have, that body height statistically significantly differentiates the player types, differences in terms of bone, fat and muscle mass percentage were also established after the elimination (partialization) of the body height effect. The findings of the multivariate analysis of covariance (MANCOVA) show that after the body height effect was eliminated, the percentages of bone, muscle and fat tissue of the individual player types did not change considerably (Table 4), and that the differences between the player groups were not statistically significant (Table 5). The results of the multivariate analysis of variance thus confirm the results of the one-way ANOVA and refute the assumption that individual types of female players can be differentiated in terms of their fat and muscle tissue.

The findings of this study as well as some other previous studies using a sample of girls from the general population of the same age[23,30,32,34] lead us to conclude that, in terms of both body height and body weight, the selected female basketball players achieve values considerably higher than the average of the general population. Regarding fat tissue and skin folds, the respective values achieved by the elite young European female basketball players are comparable to those of the general population of girls of this age or even higher. The percentage of fat tissue in the selected young female basketball players is higher than that of top senior women's basketball players[7].

This study confirms the findings of previous studies[3,13,15,17,22,25], specifically that body height and body mass are the two morphological characteristics that are predominantly differentiated among basketball player types. According to our study, these differences occur as early as among 14- and 15-year-old female basketball players. Our findings also reveal that differences between the player positions and/or player types are also found in all three somatotype components. Ectomorphy is predominantly found with centers and the least with guards. The opposite is true for mesomorphy. As regards the fat, muscle and bone tissue percentages, no differences were established between the player types before or even after partialization of the body height effect. Although previous studies reported different results, it can be said that with elite young female basketball players playing in the center position the percentage of fat tissue was not higher than with smaller and/or perimeter players. It may be concluded that the results of our study refute the assumption about player type differentiation in terms of fat and muscle tissue.

Regarding morphological characteristics in adolescence, it is sometimes difficult to separate the effects of biological growth from those of training (e.g. in muscle tissue percentage). Nevertheless, data on the profile and intensity of the morphological characteristics of different types of top European young female basketball players of this age are clearly very important for both basketball theory and practice. We wish and hope that the findings of this study will help coaches of school, club and national team selections to assess the morphological characteristics of their female players and compare them against those of the best European female basketball players. Considering that the somatotype trends in this age category are similar to those of top senior women's basketball players, such data offer a solid basis for selecting young female basketball players and directing them towards appropriate playing positions.

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MORFOLOŠKI PROFIL RAZLIČITIH TIPOVA ELITNIH MLADIH EVROPSKIH KOŠARKAŠICA

S A Ž E T A K

Košarkašku ekipu čine različiti tipovi igrača, koji se uobičajeno međosobno diferenciraju u pogledu tjelesne visine, a i nekih drugih morfoloških obilježja. U istraživanju analizirali smo morfološke karakteristike tri osnovna tipa mladih košarkašica i utvrđivali razlike među njima. Uzorak su sačinjavale mlade košarkašice (N=115) iz 28 europskih država, prosječne dobi 14,64 (±0,48) godine, koje smo podjelili u tri tipa (grupe) u odnosu na njihovu poziciju u igri: braniči (N=51), krila (N=33) i centri (N=31). U istraživanju upotrijebili smo 23 morfološka testa i na osnovu njih izračunali komponente somatotipa, postotke masnog, koštanog i mišićnog tkiva, a i neka druga morfološka obilježja. Rezultati ukazuju da postoje statistički značajne razlike između različitih tipova mladih košarkašica u pogledu tjelesne visine i težine, a i u sve tri komponente somatotipa. Što se tiče postotka masnog, koštanog i mišićnog tkiva, u istraživanju nismo utvrdili razlike. Do razlika nije došlo ni nakon eliminacije učinka tjelesne visine pomoću multivarijatne analize kovarijance. Rezultati istraživanja pobijaju pretpostavku drugih autora, da između različitih tipova košarkašica postoje razlike u pogledu masnog i mišićnog tkiva.