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THE ACUTE EFFECT OF STRETCHING ON FORCE AND POWER

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Abstract
The aim of this study is to determine levels of anthropometric features and to make comparison to training status in football and basketball players. In total 53 football and 47 basketball players, who play in the clubs of the Premier League of Bosnia and Herzegovina. Body weight, height, 6 skin folds and 4 volumes were measured. An independent t-test showed that the difference in mean body height between the football and the basketball players was statistically significant ($p<0.001$), the average difference in height was 8.7 cm in favor of the basketball player, while the differences in the mean values of the body mass were not statistically significant ($p=0.07$). BMI was statistically significant ($p= 00017$) with higher BMI for football 22.8 $\pm$ 1.4 kg/m^2 compared to 21.2 $\pm$ 5.7 kg/m^2. In relation to age, statistical significance in mean body weight and body height was not observed, while BMI differed ($p=0.001$). Juniors have lower BMIs, (21.67 $\pm$ 2.4 kg/m^2) than the seniors (23.08 $\pm$ 1.67 kg/m^2), which can be explained by the fact that seniors have trained for longer and have less fat in total body mass. A statistically significant difference in the median values of the subcutaneous fatty tissue, as well as the extent of the extremities between football and basketball players, was not established, but significant differences were found in relation to age. The study showed that there is correlation between years of training and body weight ($r = 0.209$, $p=0.037$), longer training time is associated with higher body weight. Training years were also correlated with BMI ($r=0.385$, $p<0.001$), athletes who train longer have higher BMIs. The training years correlates with percentage of fat % ($r =-0.337$; $p = 0.001$.), with a longer training time, the percentage of fat tissue in the total body mass decreases.

Key words: **Anthropometric Characteristics, BMI, Football Players, Basketball Players**

Introduction

Every high demanding sport imposes a permanent need to monitor all the parameters that are important for each sporting result. Besides physiological, biomechanical, psychological and cognitive variables, all morphological variables are equally important. Anthropometry is a method that is often used in evaluating all morphological aspects, and a method that uses measurable body surface values that are applied in the equations necessary for calculating the body composition. (Nikolic, 2014). Because of its practicality, anthropometry is also used to understand the physical characteristics (performances) of athletes in the field of sports science aiming to improve athletic performance. The assumption that anthropometric characteristics influence the physical performances of the athletes have been proven in many studies. (Gontarev, 2016).

Success in sports is directly related to certain anthropometric features, body composition, and somatotype components. (Gjonbalaj, 2018).

The whole body can be divided into two parts from the point of functions: fat body mass, which consists of fat and has low water content and lean body mass - lean body mass, which is a body rich in water. The amount of liquid contained in the lean body mass of the body is 70% and in the fat 10%. The fat mass consists of essential and deposited fats. The usual level of deposited fats in adult healthy men amounts to about 15%, of which 3% are essential fat, and 12% is found in the depots. (Burns, 1999; Okely, 2004). Athletes have less fat tissue. In his study, Wilmore and his associates gave an overview of the standard values of body fat for athletes in sports disciplines. These values are obtained by measuring skin thickness and hydro-densitometry. According to Wilmore, the percentage of body fat for the football players is from 9-12%, and for basketball players from 7-10%. (Wilmore, 1988).

In 1921, Czech anthropologist Jan Mateigka published one of the first research papers on determination of the value and changing the basic components of body mass - bone,

fat and the muscle tissue, using his new and original method of "dynamic anthropometry". Mateigka was studying the "physical efficiency" of individuals, and for the account of insurance companies in the United States. Matiegka is also the first author to list the individual, essential components of the body weight of an athlete (Čokorilo, 2010).
It is well evident that differences in body features exist between different athletes. The aim of this study was to determine the existence of the differences in some anthropometric features of footballers and basketball players and to relate them with continuous growth. Total fat tissue in the body is influenced by genetic factors, but even more so by nutrition, endocrine factors and physical activity. With the increase of fitness, the percentage of fatty tissue decreases. (Ratamess, 2003).

Methods

Participants

We conducted an observation survey involving 100 athletes, including 53 football players and 47 basketball players who play in the Premier League clubs of Bosnia and Herzegovina. All examinees were male, with an average age of 19.3 ± 4.58 years, with active participation in sports of 9.25 ± 4.46 years.

Measurement procedure

All anthropometric measurements were carried out by highly qualified, trained and experienced examiners. Body height and mass were measured using a stadometer (Seca, Leicester, UK). In addition to height and mass, six skin folds (upper arm, forearm, chest, abdomen, thighs, and lower legs) and four circumferences (forearm, forearm, thigh, and thighs) were measured.
Absolute mass of fatty tissue is calculated according to the formula F = d x TP x k2, where:
F - mass of fat and subcutaneous tissue in g,
d - mean value of measured leather folds, according to formula

d = (DKNNl + DKNPl + DKNNk + DKNPk + DKNGr + DKNTr) /6 x 0.5, where:

DKNNl - the thickness of the skin fold of the upper arm,
DKNPl - the thickness of the skin fold of the sub-arm,
DKNNk - Thickness of the skin fold of the upper leg,
DKNPk - thickness of the skin fold of the subcutaneous tissue,
DKNGr - thickness of the skin fold of the breast,
DKNTr - thickness of the skin of the abdomen,
TP - body surface area in cm2, and calculated according to the formula:

TP = 167,2 X √ (TM X TV / 1000)

k2 - constant expressed as a value of 1.3.

Statistical analysis

For the statistical analysis we used the arithmetic mean and standard deviation for the display of mean values and dispersion measures. Students' t-tests and the Pearson Correlation coefficient were used to compare variables. For the statistical analysis of the obtained data, the SPSS 21 software for Windows was used. Statistical significance of $p<0.05$ was used.

Results

From table 1 we see that the average value of the body height of the football player is 183.99 ± 5.77cm, and the basketball player is 192.78 ± 7.70; with a mean difference of -8.7 (95% CI: 11.47 to -6.11). The body mass index of the football player is 22.88 ± 1.42, while the basketball player is 21.80 ± 2.71; with a mean difference of 1.07 (95% CI: 0.19 to 1.9).

Table 1 Mean values of the anthropomorphic parameters in relation to type of sport

	Football (N=53)	Basketball (N=47)	
Anthropomorphic Parameters	Mean±SD	Mean±SD	*p*
Body height	183.99±5.77	192.78±7.70	<0.001**
Body mass	77.49±6.08	81.40±13.51	0.072
Body mass index	22.88±1.42	21.80±2.71	0.017*
DKNNl	6.72±3.21	6.85±3.23	0.836
DKNPl	4.70±1.15	5.00±1.45	0.250
DKNNk	9.44±3.31	9.99±3.65	0.438
DKNPk	7.16±3.35	8.20±3.31	0.125
DKNGr	5.74±1.86	6.25±2.61	0.259
DKNTr	7.55±3.07	8.72±3.55	0.080
Onl	28.93±1.86	28.70±2.99	0.639
Opl	26.75±1.36	27.02±2.05	0.250
Onk	55.58±5.59	55.30±4.73	0.442
Opk	38.30±2.61	38.95±2.61	0.125
% F	11.66±3.48	12.47±4.02	0.286
F(KG)	9.05±2.83	10.38±4.34	0.070

*SD – Standard deviation; **- significant at 99%; * - significant at 95%*

Mean values of anthropometric parameters in relation to age (Table 2) show the existence of statistical significance. except for body height and weight. forearm skin and subcutaneous circumference of lower leg.
The body mass index of the senior is 23.08 ± 1.67 and the junior 21.67 ± 2.40 with a mean difference of -1.41 (95% CI: -2.23 to 0.584). Among the skin combinations. the most pronounced difference in the mean values of the skin fold of the thigh. in the junior is 10.67 ± 4.01. and the seniors 8.73 ± 2.49; with a mean difference of 1.94; 95% CI: 0.61 to 3.27. Of the extremities. the most significant statistical significance of the circumference of the upper arm. in the seniors. this value is 29.73 ± 2.22. and the junior is 27.92

± 2.33; with an average difference of -1.81; 95% CI: -2.71 to -0.90. A large difference is also shown in % of fat tissue. with seniors of 10.54 ± 2.54. and for juniors 13.54 ± 4.17. with an average difference of 2.99; 95% CI: 1.61 to 4.36.

Table 2 Mean values of anthropometric parameters in relation to age

	Junior (N=50)	Senior (N=47)	
Anthropometric Parameters	Mean± SD	Mean± SD	*P*
Body height	189.06±7.65	187.19±8.36	0.246
Body mass	77.51±10.09	81.15±10.47	0.080
Body mass index	21.67±2.40	23.08±1.67	0.001**
DKNNl	7.78±3.72	5.77±2.19	0.001**
DKNPl	5.29±1.46	4.39±0.94	0.250
DKNNk	10.67±4.01	8.73±2.49	<0.001**
DKNPk	8.86±3.50	6.44±2.74	0.125
DKNGr	6.50±2.70	5.46±1.54	0.005**
DKNTr	9.24±3.68	6.97±2.52	0.080
Onl	27.92±2.33	29.73±2.22	<0.001**
Opl	26.49±1.62	27.27±1.74	0.023*
Onk	53.74±4.02	57.17±5.66	0.01**
Opk	38.39±2.17	38.83±2.34	0.330
% F	13.54±4.17	10.54±2.54	<0.001**
F(KG)	10.83±4.49	8.53±2.06	0.002**

*SD – Standard deviation; **- significant at 99%; * - significant at 95%*

The standard value of % fatty tissue (% F) in 9-11 age have 26.4 % of football players. 26.4% has a lower percentage than the standard. and 47.2% higher than the standard one. Standard values fatty tissue % (% F) of 7-10 contain 25.5% of basketball players. 2.1% have a lower percentage than standard. and 72.3% have a higher percentage of fat than standard ones (Table 3).

Table 3 Frequency values of % fatty tissue according to standard values for sport type

Football			Basketball		
% F	Frequency	Percent	% F	Frequency	Percent
<= 8.99	14	26.4	<= 6.99	1	2.1
9.00 - 11.00	14	26.4	7.00 - 10.00	12	25.5
11.01+	25	47.2	10.01+	34	72.3
Total	53	100.0	Total	47	100.0

Years of training are in correlation with body mass r=0.209; p = 0.037. Longer training periods are accompanied by a higher body mass. Years of training were in correlation with BMI r=0.385; p<0.001. Athletes with longer training age have higher BMIs (Table 4).

Table 4 Correlative relationship between years of training, body weight and BMI

	Body mass	Body mass index
Training age	r=0.209*	r=0.385**

r - Pearson Correlation **- significant at 99%; * - significant at 95%

Training age is in correlation with DKNNl (r =-24; p=0.016). Athletes with a longer training experience have lower DKNNl. Training age is in correlation with DKNPl (r=0.349; p <0.001). Athletes with a longer training experience have less DKNPl. Training age is not correlated with DKNNk (r=-0.167; p=0.097). This ratio is inversely proportional but not statistically significant. Training age is inversely proportional to DKNNk. Training age is in correlation with DKNPk (r =-0.323; p=0.001). With greater training time. DKNPk decreases. Training age is in correlation with DKNTr (r =-0.297. p=0.003). with longer training time. DKNTr decreases (Table 5).

Table 5 Correlation between training age and skin fold thickness

	DKNNl	DKNPl	DKNNk	DKNPk	DKNGr	DKNTr
Training age	r= -0.241*	r= -0.349**	r= -0.167	r= -0.323**	r= -0.174	r= 0.297**

r - Pearson Correlation **- significant at 99%; * - significant at 95%

Training age is correlated with ONI (r=0.334; p=0.001). ONk (r=0.252; p=0.012). %F (r=-0.337; p=0.001) and F(kg) (r=-0.236; p=0.018). the longer the training age the higher the ONI. ONk. %F i F(kg). Training age is not correlated with OPI (r=0.168; p=0.095). OPk (r=0.090; p=0.372).

Table 6 Correlation between training age and circumference of extremities

	ONl	Opl	ONk	OPk	% F	F(KG)
Training age	r= 0.334**	r= 0.168	r= 0.252*	r= 0.090	r=- 0.337**	r=- 0.236*

r - Pearson Correlation **- significant at 99%; * - significant at 95%

Disscusion

Monitoring of body height and body weight is a significant indicator of growth and development. Athletes often make mistakes because they think that by achieving an ideal body mass they have the proper body structure. However. changes in body weight are not a good indicator of changes in body structure. Measurement of body weight has much greater specificity and sensitivity as an indicator of growth. development and nutrition. whenever used together with body height. According to the WHO recommendations. BMI is used as a body weight categorization tool. which is unlikely to be applied to athletes because they have higher muscle mass than non-athletes.

An independent t-test in our study showed that the differences in the median values of body height between football and basketball players are statistically significant

(p<0.001 while BMI of Indian basketball players is significantly higher and was 22.63±2.33 (Burns, 1999). The average difference in height is -8.7 cm in favor of basketball players. while differences in mean body weight are not statistically significant (p=0.07). The independent t-test showed that the difference in mean BMI between footballers and basketball players was statistically significant (p=0.017). footballers had higher BMI: 22.8 ±1.4 than new program basketball players. 21.2 ± 5.7. A study in which the anthropometric characteristics of basketball players and handball players of the same age in India were examined showed that the average body height of the basketball player is 187 ± 5.1cm. which is considerably lower than the average body our height basketball players. However. our basketball players are significantly heavier 81 ± 13.5 kg than the Indian basketball players whose average body mass is 79.4 ± 7.7 kg. There is the evident difference in the resultant body mass indexes. Our respondents have BMI of 21.2, while the BMI of Indian basketball players is significantly higher for 2.63±2.33 (Burns, 1999).

In relation to age. an independent t-test did not show statistical significance in mean body weight and body height. but the BMI (p=0.001) relates of age. Juniors have lowers BMIs (21.67 ± 2.4) than the seniors (23.08 ± 1.67). which can be explained by the fact that seniors have trained longer and have a higher lean body mass.

The median values of the subcutaneous fat tissue were measured at six points: upper arm, forearm, thigh, lower leg, abdomen and chest. An independent t-test showed that there are no significant differences at a single point in mean values of subcutaneous fat between tissues football and soccer players. The same test showed that the statistical significance exists between the mean values of the subcutaneous fat tissue at all six measuring points in relation to the age. At all measuring points. there is a higher mean value of the subcutaneous fatty tissue in juniors than their older colleagues.

When using an independent t-test we analyzed the mean values of the volume of the limb, we did not get statistical significance in relation to the type of sport, but there were statistical differences in relation to the age as expected. The statistical significance was proved in the case of mean values of the extremity of the upper arm (p=0.0005), forearm (p=0.023), thighs (p=0.01). the only statistical significance was not demonstrated at the median value of the circumference of the lower leg (p=0.33). A study in which a comparative analysis of the anthropomorphology characteristics of seniors and cadets of top athletes in Serbia was carried out which showed the existence of statistical significance in the same mean values of volume as our study (Malićević, 2009).

Using the measured skin thickness values, we calculated the percentage of body fat in the total body weight (% F) and the amount of fat (kg F) for each athlete. An independent t-test has shown that the obtained mean values of % F and kg F are not statistically significant in relation to the type of sport. but they are in relation to age. both for % F, p <0.0005 and for kg F, p = 0.002. The mean value of % F for juniors is 13.54 ± 4.17 and kgF 10.54 ± 2.54 kg. while for seniors the percentage of body fat in the organism is 10.83 ± 4.49 and kg F 8.53 ± 2.06. If we compare our results with a study conducted by Malićević (2009) we can conclude that juniors involved in the research have more fat tissue seniors shown either in percentage or in kilograms (Malićević, 2009).

The average value of % F in the soccer player is 11.66 ± 3.48 and for basketball players 12.47 ± 4.02. In a study carried out by Wilmore and associates (1988). standard values of the percentage of fat tissue for athletes in certain sports disciplines were determined. According to Wilmore. the percentage of body fat for football players is 9-12%. and for basketball players is 7-10%. In our study. we determined the frequency of our respondents according to standard values of% F and obtained that 14 players have less than 9% fat tissue. 14 have a standard value of 9-12%. and 25 players have over 11% fat tissue in total body weight. In the basketball player. only one respondent has less than 7% fat tissue. 12 of them are within the standard values. while 34 of them have more than 10% fatty tissue in the total body mass. Low fat content in athletes can lead to increased risk of injury. weakening of sporting results and prolonging the recovery time after injury. However. the percentage of fat exceeding the upper limit of standard values is in a negative correlation with athlete performance and should be reduced by appropriate nutritional interventions.

Considering the years of training. our study showed that years of training in correlation with body weight (r=0.209; p=0.037). longer training time is accompanied by higher body weight. which can be explained by a higher percentage of lean body mass. Years of training are also in correlation with BMI (r=0.385. p<0.0005). athletes who train for longer have higher BMIs.

Correlation of years of training and thickness of skin folds has been made. we found that the years of training are in correlation with the mean values of skin thickness of the upper arm. forearm. lower leg. chest and abdomen. These values decline with years of training. It only showed that the years of training were not correlated with the mean value of the skin thickness of the hip. as it is growing with years of training.

Our research has shown that training years are in correlation with the upper arm and the circumference of the thigh. which increase with years of training. There is no statistical significance between years of training and the circumference of the forearm and the thigh of leg. Years of training are in correlation with% F (r =-0.337; p=0.001). With a longer training time. the percentage of fat tissue in the total body mass decreases. and the same case with kgF (r =-0.236; p=0.018). This only confirms the importance of physical activity. its impact on the body structure of the body and on the reduction of fatty tissue.

Conclusion

Based on the results of the research. we can conclude that in relation to the type of sport. the football players have higher body mass index and they are lower and lighter than the basketball players. the same is the case with the seniors in relation to the juniors. There is no difference in mean thickness of the subcutaneous fat tissue between football and basketball players. but there is a difference between seniors who have less mean skin thickness compared to juniors. The difference in mean values of the volume of extremities does not exist between football and basketball players. but the difference exists in mean values upper arms. forearms and upper legs between older and younger athletes. The higher percentages of fatty tissue were found in basketball players and juniors. Training years are in correlation with body mass. thickness of skin folds. volumes. and percentage of fatty tissue of athletes.

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