

ORIGINAL SCIENTIFIC PAPER

Differences in the Morphological Characteristics and Body Composition of Football Players of HSC Zrinjski Mostar and FC Siroki Brijeg in Bosnia and Herzegovina

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Abstract

The aim of this research was to determine the differences among the top football players of the two clubs in Bosnia and Herzegovina, HSC Zrinjski Mostar and FC Siroki Brijeg in the morphological characteristics and body composition. A sample of 50 subjects was divided into two sub-samples. The first sub-sample of the subjects consisted of 28 players of HSC Zrinjski Mostar of the average age 24.36 ± 4.14 , the champions of the Bosnia and Herzegovina in the season 2016/17, while the other sub-sample consisted of 22 players of FC Siroki Brijeg of the average age of 24.00 ± 6.22 , the champions of the Cup of Bosnia and Herzegovina in the season 2016/17. Football players were tested immediately after the end of the competition season 2016/17. Morphological characteristics in the body composition were evaluated by a battery of 11 variables: body height, body weight, body mass index, fat percentage, muscle mass, bone mass, waist size, triceps skinfold, biceps skinfold, back skinfold and abdominal skinfold. The standard central and dispersion parameters of all variables were calculated. The significance of the differences between the players of the top two football clubs in the morphological characteristics and variables for assessing body composition was determined by a t-test for independent samples. It was found that the football players of the two mentioned clubs have statistically significant differences by the three variables that estimate the bone mass, waist circumference and triceps skinfold, in favor of FC Siroki Brijeg.

Key words: football, morphological characteristics, body composition, Bosnia and Herzegovina

Introduction

A football game is said to be the most important secondary thing in the world, it gathers huge masses at stadiums and in front of TVs (Gardašević, 2010; Gardašević, Bjelica, Popović, & Milašinović, 2016). It is a highly dynamic and fast team game which, with its richness of movement, falls under category of polystructural sports games (Bjelica, 2005; Gardašević & Goranović, 2011; Gardašević & Bjelica, 2013; Gardašević & Bjelica, 2014a; Gardasevic & Bjelica, 2014b). Football is a sport that is characterized by numerous and various complex

and dynamic kinesiological activities which are then characterized by either cyclical (Gardašević, Vasiljević, & Bojanić, 2015; Bjelica, Popović, & Gardašević, 2016a; Bjelica, Popović, & Gardašević, 2016b; Sermaxhaj, Popovic, Bjelica, Gardasevic, & Arifi, 2017; Gardasevic, Bjelica, & Vasiljevic, 2017a; Gardasevic, Bjelica, & Vasiljevic, 2017b) or acyclical movement (Gardasevic, 2015; Gardašević et al., 2015; Gardašević, Bjelica, & Vasiljević, 2016a; Gardašević, Bjelica, & Vasiljević, 2016b; Gardasevic, Bjelica, Milasinovic, & Vasiljevic, 2016; Gardašević & Vasiljević, 2016; Gardasevic, Popovic, & Bjeli-



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ca, 2016). In football, top score can be achieved only under conditions of well-programmed training process (Gardašević, Bjelica, & Popović, 2015). High quality management of the training process depends on the knowing of the structure of certain anthropological capabilities and player's characteristics, as well as their development (Bjelica & Popović, 2012; Bjelica, 2013). Various researches are to be done in order to establish certain principles and norms for the transformational processes of the anthropological characteristics important for football (Gardašević, Bjelica, Georgiev, & Popović, 2012); with morphological characteristics and body composition among them as expected. Findings regarding morphological characteristics and body composition are of crucial importance for complex sports games such as football. The morphological space is defined by the longitudinal dimension of the skeleton, the transversal dimensionality of the skeleton, the mass and volume of the body (Bjelica & Fratrić, 2011). The purpose of knowing morphological characteristics is to improve skills in many sports (Carter & Heath, 1990). The morphological status of top level athletes is relatively homogeneous, depending on the sport, and it can be defined as a model of athletic achievement (Mišigoj-Duraković, Matković, & Medved, 1995). Research on morphological characteristics and body composition among athletes of different sports indicates that athletes of different sports have their own specific characteristics. Muscle mass improves performance in activities that require muscular strength and endurance, but also in those that require enviable aerobic ability (Ramadan & Byrd, 1987; Green, 1992; Rico-Sanz, 1998).

Today, football is certainly the number one sport in the world for its view and popularity (Gardašević, Georgiev, & Bjelica, 2012; Vasiljević, Gardašević, & Bojanić, 2013), and the same applies to Bosnia and Herzegovina. The two clubs that are at the top of the Premier League of Bosnia and Herzegovina and are fighting for trophies almost every year are HSC Zrinjski Mostar and FC Siroki Brijeg. In the 2016/17 competitive season, they both have achieved a staggering success, HSC Zrinjski Mostar was the champion of Bosnia and Herzegovina and FC Siroki Brijeg was the winner of the Cup of Bosnia and Herzegovina. Based on these two trophies that they have won at the end of the competition season, both clubs have acquired the right to play on the international football scene within the framework of UEFA's competitions. It became as interesting for researchers to determine the models of anthropometric characteristics and body composition of the players who play for these clubs as to determine the differences among them.

The aim of this research was to analyze the differences in some morphological characteristics and body composition among top football players, players of HSC Zrinjski Mostar and FC Siroki Brijeg, who compete in the Premier League of Bosnia and Herzegovina.

Method

The data obtained in the study of morphological characteristics and body composition are checked and prepared for processing according to the set goal. Data bases are arranged according to the features and prepared for planned statistical processing. The results obtained by statistical analysis are presented in the tables and analyzed by the corresponding logical units. In general, the results of the research, through gradualness in the explanation of individual relationships, allow seeing differences in the observed morphological measures and

body composition in accordance with the aim of the research, that is, they contribute to a clearer application of the obtained results in practice. In terms of time constraint, the research is of transversal character, and it consists of a one-off measurement of the corresponding morphological characteristics and body composition of top-level senior players.

Sample of subjects

A sample of the subjects consists of a total of 50 top-level senior players who performed in the Premier League of Bosnia and Herzegovina, divided into two sub-samples. The first one consists of 28 players of HSC Zrinjski Mostar, the average age of 24.36 ± 4.14 , Bosnia and Herzegovina's Championship winner in season 2016/17, and the second one that consists of 22 players FC Siroki Brijeg, the average age of 24.00 ± 6.22 , the winner of the Cup of Bosnia and Herzegovina for that season. The football players were tested immediately after the 2016/17 season ended.

Sample of measures

Anthropometric research has been carried out with respect to the basic rules and principles related to the selection of measuring instruments and measurement techniques standardized in accordance with the International Biological Program guidelines. For the purpose of this study, 7 morphological measures have been taken: body height (ABH), body weight (ABW), waist circumference (AWC), triceps skinfold (ATS), biceps skinfold (ABS), skinfold of the back (ASB) abdominal skinfold (AAS), and 4 bodyweight assessment variables: body mass index (BMI), fat percentage (AFP), muscle mass (AMM) and bone mass (ABM). Anthropometer, caliper, and measuring tape were used for morphological measurements. To evaluate the body composition, Tanita body fat scale - model BC-418MA, was used. The principle of this scale is based on indirect measurement of the body composition; a safe electrical signal is transmitted through the body via electrodes located in the standalone unit. The Tanita Scale, thanks to its athletics mode, enables athletes to closely monitor their body weight, health condition and form with all relevant parameters.

Method of data processing

The data obtained through the research are processed by descriptive and comparative statistical procedures. For each variable, central and dispersion parameters, as well as asymmetry and flattening measures are processed. Differences in morphological characteristics and the composition of the body of the players of these two clubs were determined by using a discriminatory parametric procedure with t-test for small independent samples, with statistical significance of $p < 0.05$.

Results

In tables 1 and 2, basic descriptive statistical parameters of anthropometric variables and body composition of the players of the two clubs, where the values of central measurements and dispersion tendencies are calculated, are shown: Arithmetic mean (Mean), Standard deviation (Std. Dev.), Variance (Variance), Minimal (Min) i Maximal (Max) values, coefficient of Curvature (Skewness) and Elongation (Kurtosis). First, the central and dispersion parameters of the variables were analyzed to evaluate the morphological characteristics and body composition of the players of HSC Zrinjski Mostar (Table 1).

Table 1. Central and dispersion parameters of variables for assessment of morphological characteristics and body composition of players of HSC Zrinjski Mostar (N=28)

Var.	Min	Max	Mean	Std.D	Variance	Skewness		Kurtosis	
						Stat.	Std. E.	Stat.	Std. E.
ABH	170.8	193.0	182.593	4.82	23.27	-.07	.44	.25	.86
ABW	70.0	90.5	78.850	5.80	33.68	.13	.44	-.92	.86
AWC	77.0	98.0	86.393	4.35	18.91	.34	.44	.95	.86
ATS	4.6	13.0	7.589	2.09	4.39	.88	.44	.63	.86
ABS	3.3	6.2	4.329	.74	.55	1.07	.44	.59	.86
ASB	3.7	13.8	9.232	2.18	4.74	.31	.44	.92	.86
AAS	4.0	15.0	8.018	2.77	7.66	.89	.44	.36	.86
BMI	21.4	26.1	23.629	1.14	1.30	.16	.44	-.47	.86
AFP	3.9	14.6	8.786	3.18	10.14	-.05	.44	-.88	.86
AMM	35.5	46.9	40.668	2.67	7.12	.05	.44	-.03	.86
ABM	2.7	5.0	3.468	.55	.30	1.36	.44	1.49	.86

Legend: body height (ABH), body weight (ABW), waist circumference (AWC), triceps skinfold (ATS), biceps skinfold (ABS), skinfold of the back (ASB) abdominal skinfold (AAS), and 4 bodyweight assessment variables: body mass index (BMI), fat percentage (AFP), muscle mass (AMM) and bone mass (ABM).

Based on the central and dispersion parameters, the values of the skewness and the kurtosis, it can be noted that all the variables are placed within the normal distribution boundaries. It can be seen based on the value of skewness as well, that the two variables: bone mass (ABM) and biceps skinfold (ABS) have mild asymmetry, and though not statistically significant on behalf of better results, they are a positive sign, since it is essential for football players to have lower values of subcutaneous fat tissue and bone mass value. By the value of the kurtosis, it can be seen that the bone mass variable (ABM)

has a mild leptokurticity, not statistically significant, which indicates that a greater number of results in this variable are arranged around the arithmetic mean. Generally, according to all statistical parameters, it can be concluded that here we have some top football players; that there is a normal distribution in all variables and that the results that prevail are superior to the arithmetic mean, which is not statistically significant because it is to be expected that regarding players of a professional football club, there is no too large a span between the results of analyzed variables.

Table 2. Central and dispersion parameters of variables for assessment of morphological characteristics and body composition of players of FC Siroki Brijeg (N=22)

Var.	Min	Max	Mean	Std.D	Variance	Skewness		Kurtosis	
						Stat.	Std. E.	Stat.	Std. E.
ABH	167.2	195.5	183.286	6.75	45.59	-.59	.49	.34	.95
ABW	64.6	87.9	77.600	6.57	43.12	-.46	.49	-.52	.95
AWC	78.0	92.0	83.773	3.84	14.75	.59	.49	.14	.953
ATS	4.0	9.2	5.877	1.17	1.37	1.06	.49	1.81	.95
ABS	3.6	6.6	4.577	.75	.57	1.00	.49	1.01	.95
ASB	6.6	13.6	8.959	1.75	3.05	.92	.49	1.14	.95
AAS	4.8	13.6	8.509	2.49	6.19	.45	.49	-.69	.95
BMI	20.7	26.8	22.991	1.51	2.28	.37	.49	.34	.95
AFP	4.2	14.5	9.841	2.69	7.22	-.38	.49	-.18	.95
AMM	33.1	46.1	39.573	3.26	10.61	-.17	.49	.23	.95
ABM	2.5	3.8	3.168	.32	.10	-.16	.49	.19	.95

Based on the central and dispersion parameters, the values of skewness and kurtosis of the players of FC Siroki Brijeg, it can be stated that all the variables are within the normal distribution boundaries and that the values are very similar to those of the players of HSC Zrinjski Mostar. It can also be stated that the players of FC Siroki Brijeg are younger on average, have less body weight than the players of FC Siroki Brijeg, and have a higher percentage of body fat, but also lower values of skinfolds, though insignificantly. However, a comparative statistical procedure, t-test (Table 3), will show whether it is statistically significant. By the value of the skewness, it can be noticed that in the variables of the triceps skinfold (ATS) and skinfold of the biceps (ABS), there was a slight inclination on the side of the

lower results, which is good because subcutaneous fat is a disrupting factor for professional athletes. The values of the kurtosis of variables of the skinfold of triceps (ATS), the skinfold of the biceps (ABS) and the skinfold of the back (ASB) form a slight leptokurtic curve, which witnesses the fairness of playmates of FC Siroki Brijeg in these three variables. In order to determine whether there are statistically significant differences in the analyzed variables in the top football players of these two clubs, the statistical procedure t-test (Table 3) was applied.

Based on the obtained values of t-test results, it can be noted that there are statistically significant differences in three variables at $p < 0.05$. It is one of the variables that evaluate the body composition, bone mass (ABM), and the other two are mor-

Table 3. T-test values between the arithmetic mean of variables for the evaluation of morphological characteristics and body composition of players of HSC Zrinjski Mostar (N=28) and FC Siroki Brijeg (N=22)

Variable	Club	Mean	Std. D.	Std. E.M.	t-test	Sig.	Mean Difference
ABH	ZRI	182.593	4.8235	.9116	-.424	.674	-.6935
	SIR	183.286	6.7517	1.4395			
ABW	ZRI	78.850	5.8036	1.0968	.714	.479	1.2500
	SIR	77.600	6.5667	1.4000			
AWC	ZRI	86.393	4.3490	.8219	2.224	.031	2.6201
	SIR	83.773	3.8413	.8190			
ATS	ZRI	7.589	2.0959	.3961	3.429	.001	1.7120
	SIR	5.877	1.1711	.2497			
ABS	ZRI	4.329	.7418	.1402	-1.169	.248	-.2487
	SIR	4.577	.7534	.1606			
ASB	ZRI	9.232	2.1768	.4114	.479	.634	.2731
	SIR	8.959	1.7459	.3722			
AAS	ZRI	8.018	2.7686	.5232	-.651	.518	-.4912
	SIR	8.509	2.4877	.5304			
BMI	ZRI	23.629	1.1421	.2158	1.700	.096	.6377
	SIR	22.991	1.5115	.3223			
AFP	ZRI	8.786	3.1849	.6019	-1.244	.220	-1.0552
	SIR	9.841	2.6878	.5730			
AMM	ZRI	40.668	2.6689	.5044	1.307	.197	1.0951
	SIR	39.573	3.2571	.6944			
ABM	ZRI	3.468	.5525	.1044	2.263	.028	.2997
	SIR	3.168	.3183	.0679			

phological measures of the waist circumference (AWC) and the skinfold of the triceps (ATS). It can be stated that the football players of HSC Zrinjski Mostar have statistically significantly higher bone mass, waist circumference and skinfold of the triceps than the players of FC Siroki Brijeg. In all other variables the differences are negligible and not statistically significant.

Discussion

The aim of this study was to determine the difference in the morphological characteristics and body composition of the top players of the two football clubs in Bosnia and Herzegovina, HSC Zrinjski Mostar, winner of the Championship and FC Siroki Brijeg, winner of the Cup in the 2016/17 season. A sample of 50 respondents was divided into two sub-samples. The first sub-sample consisted of the 28 players of HSC Zrinjski Mostar of 24.36 ± 4.14 age on average, who were older indeed but not much different in a statistically significant way than the 22 players of FC Siroki Brijeg, who made the second sub-sample of 24.00 ± 6.22 age on average. The results were obtained by using a battery of 11 tests in the area of morphological characteristics and body composition. By looking into the basic descriptive statistical parameters, it can be concluded that we have examined professional sportsmen indeed. It can be noticed that the players of both clubs are of the approximately similar mean values of the variables analyzed, which is not surprising because these are the top two clubs in Bosnia and Herzegovina, a state where there is also a great concentration of good players. The t-test results showed a statistically significant difference only in three variables. The first one is one of those that are important for body composition and for bone mass of football players, which has shown that the players of HSC Zrinjski Mostar have significantly higher bone mass values than the

players of FC Siroki Brijeg. Similar results have been obtained in a recent research of Gardasevic, Bjelica, Popovic, Vasiljevic and Milosevic (2018) where statistically significant differences between the values of these variables have been found between the players of FC Buducnost, who won the championship that season, and the players of FC Mladost from Podgorica, a runner-up, in favor of the first-mentioned, have been found. The second variable in which a statistically significant difference has been found is a variable that estimates waist circumference, where the playmates of HSC Zrinjski Mostar also have a statistically higher value than the players of FC Siroki Brijeg. Also, at the variable of triceps skinfold (ATS), players of FC Siroki Brijeg have shown statistically better values because a smaller number means a better result when the disrupting factor of subcutaneous fat on playing football is taken into account. Similar results have been obtained in a recent study of Bjelica, Gardasevic and Vasiljevic (2018), where the football players of FC Sutjeska, winners of the Cup of Montenegro, had significantly lower skinfold value than the football players of FC Mladost, runner-up in the league of Montenegro. Also, Corluka and Vasiljevic (2018) have shown that football players of FC Sutjeska, were dominant in these parameters in Montenegro, and that they had significantly lower values of skinfolds than the football players of FC Buducnost Podgorica, winners of the Championship of Montenegro.

For other variables, some values are better for players of HSC Zrinjski Mostar and some for players of FC Siroki Brijeg, although, insignificantly for statistics, which indicates that these players have very similar anthropometric parameters and body composition, which is again, not surprising, considering that these two clubs shared the two possible trophies in the 2016/17 competitive season in Bosnia and Herzegovina. The values ob-

tained in this research can be useful for coaches of these clubs for making a comparison of their players with others and formulate their work in a way that enables reduction of those parameters that are not good, and raise those that are good to a higher level. That will surely make their football players even better and more successful. Also, both clubs should turn to other researches and check the functional-motoric status, psychological preparation as well as tactical training of their players and analyze whether there is room for their improvement. The results obtained in this research can serve as model parameters for the estimated variables for players of all other football clubs in Bosnia and Herzegovina, because the players that have been analyzed here, were among the best and the most successful football players in Bosnia and Herzegovina at the end of the competitive season of the Premier League of Bosnia and Herzegovina 2016 / 17.

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Conflict of Interest

The authors declare that there are no conflict of interest.

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