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Differences in morphological characteristic of footballers over two preparatory periods

Nebojša Nešić[1], Vesna Šeper[1], Martino Bataković[1], Darijo Sebeledi[2]

[1]College of Applied Sciences „Lavoslav Ružička" in Vukovar, Croatia, [2] "HNK Vukovar 1991" Vukovar, Croatia

Abstract

The morphological characteristics of athletes are one of the essential factors of sporting achievements in different sports. Football is one of the sports where monitoring changes in the morphological characteristics is a standard process for monitoring training effects. Purpose of this paper was to show changes in the morphological characteristics of footballers over two preparatory periods during one year. Morphological characteristics of footballers were analyzed using a bioelectric impedance method on body analyzer Tanita MC 780, height was measured using SECA type 220. Statistical analysis was done with IBM SPSS Statistics 26, with statistical significance set at p≤0.05. During the first preparatory period, statistically significant changes were found for the following variables: Total body water (TBW) (MD= -0.86; p=0.02), Intra celular water (ICW) (MD= -0.70; p=0.03), Percent Muscle Mass (PMM) (MD= -1.04; p=0.012). During the second preparatory period, statistically significant changes were found for the following variables: Percent Body Fat (PBF) (MD= -1.40; p=0.02), TBW (MD= 1.25; p=0.01), ICW (MD= 0.10; p=0.004), PMM (MD= 1.30; p=0.01). Concerning the obtained results, we conclude that the training process is not the only factor influencing the morphological characteristics of athletes.

Keywords: *Body Composition, Body Water, Athletes, Muscles*

Introduction

Different sports require different adaptations of athletes in terms of motor and functional ability development. Training processes are intended for the development of specific sports needs in order for athletes to achieve the best possible results. Except for the development of specific abilities of athletes, training processes influence the composition of the athletes' body, percentage of fat and muscle, amount of water in the body etc. Football is an extremely demanding sport activity that requires specific physical adjustments from sportsmen in order to achieve maximum impact on the field. Physique of the football player is closely related to its performance (Spehnjak et al., 2021).

In football, the specific position on the field and the level of competition are set by different requirements, which is why the players differ among themselves in the structure of the body considering the position they have on the ground and the level of competition they participate in (Leao et al., 2019; Slimani & Nikolaidis, 2017) The correlation between morphological characteristics and specific test results for footballers was also found in younger age groups (Esco et al., 2018).

Football is an extremely popular sport all over the world and there are many players as well as research related to fotball. Over time, the minimum requirements that a football player has to meet for a certain level of competition in order to be successful have been defined (Dodd & Newans, 2018), which helps athletes selection. Everything is further complicated considering that performance and body structure are also affected by other factors such as nutrition (Hulton et al., 2022), and periods of the season (Clemente et al., 2021). In order to establish the current condition of the player, i.e. its performance and morphological characteristics, various measurement and testing methods are used. As regards to morphological characteristics, the sim-

Correspondence:

N. Nešić
College of Applied Sciences „Lavoslav Ružička" in Vukovar, Department of Health Studies, Županijska 50, 32000 Vukovar, Croatia
E-mail:nnesic@vevu.hr

ple, widely represented and reliable method of analysis is the bioelectric impedance (BIA) (Tereso et al., 2021; Vasold et al., 2019). Analysing the morphological characteristics of football players, we receive feedback about the positive impact or lack of training processes on the athletes' organism, as well as indirect information about eating habits. (Devlin et al., 2017). The aim of this paper was to analyse changes in the morphological characteristics of football players during two preparatory periods in one season.

Methods

The research was conducted at the College of Applied Sciences „Lavoslav Ružička" in Vukovar during 2021. The measurements were taken on the 29th of January, 16th of March, 15th of July and 18th of September. The sample consisted of football players from 1st team of the Vukovar '91 football club competing in the 3rd Croatian National League.

The initial sample consisted of 11 players age 22.11 ± 1.9 years, 2 players did not participated in all measurements and their results were not taken into account.

The morphological characteristics of the players were analysed using the bioelectric impedance (Tanita MC 780), the height was measured using the SECA 220 with an accuracy of 0.1 cm. The measurements were made 4 times, before and after each preparatory period. Body weight (TT/kg), body height (TV/cm), body mass index (BMI/kg/m^2), percent body fat (PBF/%), total body water (TBW/%), extra cellular water (ECW/%), intra cellular water (ICW/%), percent muscle mass (PMM/%) were measured. All measurements were made at the same time between 08:00 and 09:30 hours, at the same room temperature (22°C) according to the BIA method: without food and drink before measurement, empty bladder, without intense physical activity during the previous 24 hours.

Ethics

This study was approved in advance by the Ethics comitee of College of Applied Sciences „Lavosalv Ružička" in Vukovar. Each participant voluntarily provided written informed consent before participating.

Statistical reporting

One factor analysis of variance for repeated measurements with Bonfferoni correction was used for statistical data processing. Statistical significance was determined at p≤0.05. Data were processed using IBM SPSS Statistics 26 (IBM Statistics, 2019).

Results

Under the influence of factor time/training, body weight did not change significantly during four measurements (F(3, 0.77)=0.57; p=0.64; Part η^2=0.07). The body mass index did not change significantly (F(3, 0.79)=0.56; p=0.65; Part η^2=0.07) (Table 1).

Table 1. Basic Descriptive Statistics and Characteristics of Distribution for Variables: Age, Height, Body Weight, Body Mass Index Presented by Arithmetic Mean and Standard Deviation

variables	N	Minimum	Maximum	AM	SD	p value
age	9	20,00	26,00	22,11	1,90	
height	9	158,00	197,50	175,61	10,78	
BW1	9	61,50	87,20	70,70	8,59	0.64
BW2	9	61,10	84,60	70,78	8,06	
BW3	9	60,50	86,60	71,36	8,97	
BW4	9	61,90	85,80	70,99	8,14	
BMI1	9	19,50	25,10	22,92	1,61	0.07
BMI2	9	19,40	25,10	22,96	1,72	
BMI3	9	19,20	25,50	23,13	2,00	
BMI4	9	19,60	25,30	23,02	1,80	

Note. TT: body weight; BMI: body mass indeks; AM: arithmetic mean; SD: standard deviation; N: number of cases

Statistically significant changes occurred in the variables percent body fat (F(3, 6.14)=4.91; p=0.008; Part η^2=0.38) and percent muscle mass (F(3, 4.47)= 9.83; p=0.00; Part η^2=0.55) (Table 2).

Variables related to body water, total body water (F(3, 3.65)=11.39; p=0.000; Part η^2=0.59), intracellular water (F(3,

Table 2. Basic Descriptive Statistics and Characteristics of Distribution for Variables Percentage of Body Fat, Percentage of Muscle Mass Presented by Arithmetic Mean and Standard Deviation

variables	N	Minimum	Maximum	AM	SD	p value
PBF1	9	9,40	16,90	14,86	2,21	0.008
PBF2	9	6,20	16,70	13,53	3,23	
PBF3	9	7,10	17,70	13,31	3,10	
PBF4	9	9,70	18,20	14,83	2,68	
PMM1	9	49,80	70,60	57,16	6,90	0.00
PMM2	9	50,50	71,20	58,13	6,82	
PMM3	9	50,70	74,00	58,72	7,52	
PMM4	9	49,90	71,20	57,44	7,00	

Note. PBF: percent body fat; PMM: percent muscle mass; AM: arithmetic mean; SD: standard deviation; N: number of cases

Table 3. Basic Descriptive Statistics and Distribution Characteristics for Variables Total Body Water, Extracelluar Water, Intracellular Water Represented by Arithmetic Mean and Standard Deviation

variables	N	Minimum	Maximum	AM	SD	p value
TBW1	9	40,00	52,20	43,90	4,45	0.000
TBW2	9	40,60	52,80	44,76	4,39	
TBW3	9	40,80	55,20	45,29	4,99	
TBW4	9	40,10	52,70	44,09	4,57	
ECW1	9	15,80	20,30	17,27	1,54	0.01
ECW2	9	15,90	20,10	17,42	1,42	
ECW3	9	16,00	20,60	17,58	1,60	
ECW4	9	15,10	20,10	17,22	1,57	
ICW1	9	23,70	31,90	26,63	2,94	0.001
ICW2	9	24,70	32,70	27,33	3,01	
ICW3	9	24,80	34,60	27,71	3,41	
ICW4	9	23,80	32,60	26,76	3,16	

Note. TBW: total body water; ECW: extracellular water; ICW: intracellular water; AM: arithmetic mean; SD: standard deviation; N: number of cases

2.29)=11.92; p=0.000; Part η^2=0.60) and extracellular water (F(3, 0.23)=4.33; p=0.01; Part η^2=0.35) have also changed significantly (Table 3).

After Bonfferoni correction statistically significant differences were maintained for the following variables: percent body fat between the third and fourth measurement, i.e. within the second preparatory period (13.31%±3.10% vs. 14.83%±2.68%; MD=-1.52; p≤0.05), total body water between the first and second measurement during the first preparatory period (43.90%±4.45% vs. 44.76%±4.39%; MD=-0.86; p≤0.05) and between the first and the third measurements (43.90%±4.45% vs. 45.29%±4.99%; MD=-1.38; p≤0.05), between the initial measurement and the end of the first part of the season. Statistically significant changes of total body water were also recorded in the second preparatory period between the third and fourth measurement (45.29%±4.99% vs. 44.09%±4.57%; MD=1.20; p≤ 0.05) (Table 4.).

Intracellular water changed significantly during the first preparatory period between the first and second measurement (26.63%±2.94% vs. 27.33%± 3.01%; MD=-0.70; p≤0.05), as well as between the first and the third measurement (26.63%±2.94% vs. 27.71%±3.41%; MD=-1.08; p≤0.05). Statistically significant changes were also observed during the second preparatory period between the third and fourth measurement (27.71%±3.41% vs. 26.76% ±3.16%; MD=0.96; p≤0.05) (Table 4.).

Table 4. Differences between observed variables after Bonferroni correction

variables		AM±SD	MD	p value
PBF3 (13,31±3,10)	PBF1	14,85±2,20	-1,54	0.31
	PBF2	13,53±3,23	-0,22	1.00
	PBF4	14,83±2,68	-1,52	0.03
TBW1 (43,90±4,45)	TBW2	44,75±4,40	-0,86	0.04
	TBW3	45,29±5,00	-1,39	0.01
	TBW4	44,09±4,57	-0,19	1.00
TBW3 (45,29±5,00)	TBW4	44,09±4,57	1,20	0.02
ICW1 (26,63±2,94)	ICW2	27,33±3,01	-0,70	0.02
	ICW3	27,71±3,41	-1,08	0.01
	ICW4	26,75±3,16	-0,12	1.00
ICW3 (27,71±3,41)	ICW4	26,75±3,16	0,96	0.01
PMM1 (57,15±6,90)	PMM2	58,13±6,82	-0,98	0.05
	PMM3	58,72±7,52	-1,57	0.02
	PMM4	57,44±7,00	-0,29	1.00
PMM3 (58,72±7,52)	PMM4	57,44±7,00	1,28	0.03

Note. PBF: percent body fat; TBW: total body water; ICW: intracellular water; PMM: percent muscle mass; AM: arithmetic mean; SD: stansard deviation; MD: mean difference.

Percent muscle mass changed significantly between the first and second measurement during the first preparatory period (57.16%±6.90% vs. 58.13%±6.82; MD=-0.98; p≤0.05), as well as between the first and the third measurement (57.16%±6.90% vs. 58.72%±7.52%; MD=-1.57; p≤0.05). Statistically significant changes were also observed during the second preparatory period or between the third and fourth measurement (58.72%±7.52% vs. 57.44%±7.00%; MD=1.28; p≤0.05) (Table 4.).

Discussion

Total body weight did not change significantly during both the preparation periods and the season, however, there were significant changes in morphological characteristics. Percent body fat (PBF) which is one of the important factors affecting the performance of players, with its lowest value (13.31±3.10%), is far greater than for elite players in Croatia (11.9 ± 3.1%) (Sporiš et al., 2009). During the first preparatory period, there was a decline in PBF which was not significant, the decline continued during the season at the end of which it reached the abovementioned lowest value. It is interesting that the only significant change in PBF was recorded during the second preparatory period and was negative, there was an increase in the percentage of fat tissue. The expected result for PBF during the preparations is its reduction (Krespi et al., 2018). The reason for this result is probably the combination of the training process and the diet of the athletes (Devlin et al., 2017).

The total body water (TBW) as well as intracellular water (ICW) increased significantly during the first preparatory period and during the season, then significantly reduced during the second preparatory period. Since water is the basic component of the human body and represents 76% of muscle mass (Lorenze et al., 2019) these changes also indicate changes in muscle mass. ICW is associated with muscle strength and functional capacity, indicating the quality of muscle and cellular hydration (Lorenze et al., 2019). As the content of TBW and ICW is positively linked to the muscle function (Hetherington-Rauth et al., 2019), and hence to the performance of the players (Martins et al., 2021), it can be assumed that their reduction during the second preparatory period affected the reduction of the same, which is contrary to what the preparations are intended to achieve.

Since the muscle mass is directly related to the amount of body water, this change in the amount of TBW and ICW is directly related to the changes in the percentage of muscle mass (PMM), which was changed in the same way as TBW and ICW. There was an increase during the first preparatory period and during the season, while during the second preparatory period there was a decrease. Since muscle mass is positively related to muscle function (Alvero-Cruz et al 2021), it should be emphasized that reduction in PMM during the second preparatory period is a negative effect.

The goal of training processes during the season or preparations in every sport, including football is to improve the ability of athletes. Specific training lead to the improvement of certain abilities and morphological characteristics of athletes (Styles et al., 2016; Suares - Aroness et al., 2018).

This study analyses only the body components of football players without testing their motor and functional abilities. Regardless of this deficiency and considering the relationship between morphological characteristics, muscular and functional abilities, it can be said that the first preparatory period has achieved its goal and the second has not.

Analysing the morphological characteristics of football players using a bioelectric impedance over a shorter period of time would help prompt interventions to avoid any adverse changes.

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