DIFFERENCES IN MAXIMUM OXYGEN CONSUMPTION OF FOOTBALL PLAYERS OF DIFFERENT POSITIONS IN THE TEAM

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Abstract

The aim of this research is to determine the differences between the aerobic functional abilities of football players from different positions in the team, which should serve as a starting point in planning and monitoring the training process of football players. VO2max, as a basic parameter of functional abilities, was obtained by applying a laboratory progressive test on the treadmill. The sample of respondents was composed of 57 respondents (GOD = 22.47 ± 3.78SD), football players of clubs competing in the first and second leagues of Serbia from the area of Vojvodina, of which 8 goalkeepers, 16 defensive, 17 midfielders and 16 attackers. To test the functional capabilities (oxygen consumption - VOmax), we used a test of progressive continuous load on the treadmill with increasing load per minute through a "breath-by-breath" gas analyzer (Quark PFT ErgoCPET, Cosmed, Italy), which gave data on ventilation and spiroergometric parameters of the subjects by different positions in the team. Anthropometric measures of body weight- (TM) and body height- (TV) were applied to test the morphological characteristics of the subjects. SPSS 20.0 software package was used for data processing. In order to determine the statistically significant differences of the measured variables between football players by positions, a one-factor anova of different groups, the level of statistical significance ($p < 0.05$) was used. The obtained results of maximum oxygen consumption indicated that there is a statistically significant difference in aerobic abilities between goalkeepers and players in other positions, and they are certainly a consequence of the physiological requirements placed before them and the different training process. The highest mean value of VO2 max had midfielders (53.3 ± 1.9 ml / kg / min), followed by attackers (52.9 ± 4.4 ml / kg / min), defensive players (51.8 ± 3, 3 ml / kg / min) while the lowest values were recorded in the goalkeeper (50.5 ± 1.8 ml / kg / min). There is a logical conclusion that the need for running midfielders is the greatest, and the goalkeeper the least, and that the results are the result of training processes and different requirements for individual positions in the team.

***Key words**: football, VO2 max, maximum oxygen consumption, aerobic capacity*

Introduction

Dominant movement activities in football are in the first place running, with medium and high intensity. In order for players to successfully carry out technical and tactical activities in modern football, a high level of their energy capacity is necessary.

Football is characterized by a continuous flow of activity with variable intensity of play and a very low coefficient of success, when viewed in terms of goals scored and time spent on the field, as well as in terms of possession of the ball by individuals. Footballers run about 10km during the game (Mayhew & Wenger, 1985; Reilly et al., 1993; Mikić et al., 2002). Football, as a representative of the kinesiology of complex activities, requires intermittent work with an intertwining of aerobic and anaerobic activities, so the athlete is required to have an efficient energy system that will allow him to be active all 90 minutes at full pace. The data presented (Živanić et al., 1999) are related to the physiological profile of football players, showing that the average distance covered during the game, Serbian first league football players, 8-12km with an aerobic / anaerobic work ratio of 90% and 10%. Since the energy capabilities of the human body are certainly the most important factors that determine the limits of physical ability, including sports, it is allowed to identify physical ability with the size of energy capacity (Ponorac et al., 2005). The functional abilities of athletes are the cardiorespiratory and aerobic abilities responsible for oxygen transport, as well as the metabolic abilities responsible for aerobic and anaerobic abilities. The cardiovascular system is responsible for a large number of functions in the body. The role of this system is significant in the delivery of oxygen and nutrients, elimination of carbon dioxide and metabolic by-products from muscles and other tissues, transport of complex substances to the liver and other organs, help regulate body temperature and delivery of hormones to target tissues. Therefore, improving the cardiovascular system increases the overall physiological function of athletes (Drid, 2012).

The essence of functional testing in sports is knowledge of the metabolic requirements of a

specific activity or sport. Many tests used to quantify physiological capacities rely on metabolic processes that affect the intensity or duration of activity. The intensity and duration of activity will determine the predominance of one energy system - phosphocreative, glycolytic or oxidative, in order to regenerate muscle adenosine triphosphate (Malacko and Doder, 2008; Ostojić, 2014). Good aerobic ability undoubtedly affects the performance of explosive movement actions both in terms of quantity (number of sprints per game) and quality (without slowing down). Research shows that, especially in football, a good aerobic capacity of the body is one of the most important prerequisites for achieving top results. Thus, the study of the Hungarian First Federal League shows a significant correlation between the position in the table and VO2 max, where the first-placed team at the end of the championship had the highest mean VO2 max, the second team slightly lower, the third even lower (Apor, 1988). The energy needs of the organism in football vary and largely depend on the rank of the competition, the position in the team, the model of the game, the phase of the training cycle (Reilly, Bangsbo, Franks, 2000). The upper limit that determines the body's ability to take in oxygen is represented by maximum oxygen consumption or maximum aerobic power (VO2max). Maximum aerobic power or oxygen consumption (VO2max) is defined as the maximum amount of oxygen (O2) that the body is able to consume in 1 minute (Mikić, et al., 2005). Maximum consumption is expressed in milliliters of oxygen per minute (ml / min). Functional diagnostics in football covers a wide range from registration of general functional abilities in routine laboratory sports-medical practice, through deeper insight into individual physiological and biochemical processes to research and measurements on sports fields and in situational conditions (Fratrić, 2006; Sudarov, Fratrić, 2010, Mikić et al., 2019).

In football (VO2max) it does not reach the high values characteristic of endurance sports (cross-country skiing, marathon, triathlon), where the values are often above 80ml / kg / min. Values for top players are characterized in the range of 55-70ml / kg / min with higher values typical for top players of maximum preparedness (Rhodes et al., 1986; Mandine et al., 1990; Butt and Fant, 1999; according to Mikić et al. ., 2005). The subject of this paper is the relative maximum oxygen consumption (VO2max), body height and body weight of football players who play in different positions in the team. The aim of this research is to determine the differences between the aerobic functional abilities of football players from different positions in the team, which should serve as a starting point in planning and monitoring the training process of football players. VO2max, as a basic parameter of functional abilities, was obtained by applying a laboratory progressive test on the treadmill.

METHODS

Testing and measurement of functional abilities and measurement of anthropometric characteristics were performed on a sample of 57 respondents (AGE = 22.47 ± 3.78SD), football players of clubs competing in the first and second leagues of Serbia from Vojvodina, of which 8 goalkeepers, 16 defensive , 17 midfielders and 16 strikers (Table 1).

Table 1. Basic age characteristics of respondents-football players

Position in the team	Number of respondents	Age (yr)
goalkeepers	8	23,75±2,49
defensive	16	22,12±2,96
midfielder	17	21,65±4,20
attackers	16	23,06±4,55
TOTAL NUMBER	57	22,47±3,78

An anthropometer and a tailor's centimeter tape were used to measure the body height and weight of the football players. The measurement of morphological characteristics was performed immediately before the testing of functional abilities - maximum oxygen consumption in the cabinet for morphological-functional testing of the Provincial Institute for Sports and Sports Medicine in Novi Sad.

Ventilation and spiroergometric parameters were measured by a progressive continuous load test on the treadmill with increasing load per minute via a breath-by-breath gas analyzer (Quark PFT ErgoCPET, Cosmed, Italy). The test protocol began with reading the monitored values at rest for one minute, after which the tape was run at a speed of 5km / h for the next 2 minutes to warm up the subjects. At a speed of 7km / h, the subjects started running, while the lane progressively accelerated at 0.5km / h every 30 seconds. The test ended with the athlete giving up further running due to the inability to track track speed. The band inclination throughout the test was 2% and was constant.

Sample of respondents The sample of respondents was composed of 57 respondents (AGE = 22.47 ± 3.78SD), football players of clubs competing in the first and second leagues of Serbia from the area of Vojvodina, of which 8 goalkeepers, 16 defensive, 17 midfielders and 16 attackers.

Sample variables To test the functional capabilities (oxygen consumption - VOmax), we used a test of progressive continuous load on the treadmill with increasing load per minute through a "breath-by-breath" gas analyzer (Quark PFT ErgoCPET, Cosmed, Italy), which gave data on ventilation and spiroergometric parameters of the subjects by different positions in the team. To test the anthropometric characteristics of the subjects, tests were used to assess the anthropometric

characteristics of body weight (BW) and body height (BH).

Data processing methods SPSS 20.0 software package was used for data processing. Data analysis was performed using descriptive statistics to calculate basic descriptive statistics data of functional and morphological variables. In order to determine the statistically significant differences of the measured variables between football players by positions, a one-factor anova of different groups, the level of statistical significance ($p < 0.05$) was used.

RESULTS AND DISCUSSION

The analysis of descriptive statistics (Table 2) of the observed anthropological variables indicates the homogeneity of all groups of athletes. The values of the asymmetry coefficient (Sk-skjunis) and the curvature coefficient (Kurt-kurtozis) indicate that the distributions of the analyzed variables do not deviate significantly from the normal distribution. The average height of football players is 182.02 ± 7.81 cm, and body weight 78.55 ± 7.54 kg. The values of the coefficient of variation (<15%) indicate that the group of football players is homogeneous, ie. that footballers in different positions in the team have similar results in the measured variables.

Table 2. Basic descriptive indicators of anthropometric and spiroergometric variables for the whole sample

VARIABLES	J.M.	N	MIN	MAX	AS	SD	CV (%)	Sk	Kurt
Body height	cm	57	164,00	197,00	182,07	7,81	4,29	-0,12	-0,66
Body weight	kg	57	57,50	92,30	78,55	7,54	9,60	-0,34	0,09
Oxygen consuption VO_{2max}	(ml/kg/min)	57	46,47	66,21	57,30	4,64	8,10	-0,02	-0,49

Legend: JM-unit of measure, N-number of entities in the study, MIN-minimum values of measurement results, MAX-maximum values, AS-arithmetic mean, SD-standard deviation, CV- coefficient of variation, Sk-coefficient of asymmetry (distribution slope), Kurt-curvature coefficient (elongation of distribution)

Using one-way analysis of variance (ANOVA), the results were compared between groups in some anthropometric characteristics and indicators of aerobic abilities of football players and determined based on the value of F that there are statistically significant differences in body height and body mass, maximum oxygen consumption (VO2max). The values of the Shapiro-Wilk test (SWp> 0.05) indicated the normality of the distribution of all analyzed variables.

In (Table 3) it is clearly seen that there is a statistically significant difference ($p < 0.05$) between football players in the following measured variables: Body height (BH), Body mass (BW), VO2max. The values of the Levene test (Lev p> 0.05) tell us about the homogeneity of all observed variances.

Table 3. Basic descriptive statistics and differences of footballers by positions

Variables	Pozicija u timu	AS	SD	SWp	Lev p	F	p
Body height (BH)	goalkeepers	192,39	3,39	0,52	0,29	14,75	0,00
	defensive	184,66	6,40	0,35			
	midfielder	175,82	5,73	0,88			
	attackers	180,97	6,09	0,94			
Body weight (BW)	goalkeepers	87,77	3,34	0,82	0,41	16,32	0,00
	defensive	80,40	6,54	0,58			
	midfielder	72,08	6,39	0,78			
	attackers	78,97	4,93	0,29			
VO_{2max} (ml/kg/min)	goalkeepers	52,61	3,40	0,34	0,11	4,82	0,01
	defensive	56,77	5,21	0,18			
	midfielder	59,31	4,37	0,16			
	attackers	58,06	3,18	0,58			

Legend: AS-arithmetic mean, SD-standard deviation, SWp-level of statistical significance of Shapiro Wilk coefficient, Lev p-level of statistical significance of Levele's coefficient, F-value of An's indicator, p-level of statistical significance of univariate analysis of variance

To determine exactly which groups there are statistically significant differences, the use of the LSD Post Hoc Test was resorted to.

Using the Tukey HSD test, it was found that in the variable Body weight (BW), the mean value of group 1 (AS = 87.77, SD = 3.34) was statistically significantly different from the mean value of group 2 (AS = 80.40, SD = 6.54), group 3 (AS = 72.08, SD = 6.39) and group 4 (AS = 78.97, SD = 4.93). Mean values (BW) of defensive players are higher than midfielders, attackers than midfielders, at the level of statistical significance ($p < 0.05$).

When it comes to body height (BH), a statistically significant difference was observed in the following groups of footballers. Goalkeepers' mean values (BH) differ statistically significantly and are higher than defensive and midfielders and attackers. Statistically, the values of the body height of defense and attack players differ significantly from midfielders in favor of defensive and offensive players. The best aerobic abilities were played by midfielders (59.31 ml / kg / min), attacking players (58.06 ml / kg / min), then defensive players (56.77 ml / kg / min) who differed statistically significantly from Goalkeeper VO2max (52.61 ml / kg / min).

(Table 4) presents the values of arithmetic mean differences and statistically significant differences in aerobic capacity parameters between four groups of football players using univariate analysis of variance (ANOVA), where it can be seen that the mean values of VO2max goalkeepers differ statistically significantly and are less players and attackers.

Table 4. Differences between football players from different positions in body weight, body height and maximum oxygen consumption

Variable	(I) group	(J) group	*Difference AS (I-J)*	*p*	Variable	(I) group	(J) group	*Difference AS (I-J)*	*p*	Variable	(I) group	(J) group	*Difference AS (I-J)*	p
***Body* weight (BW)**	1	2	**7,37**	**0,02**	**Body height (BH)**	1	2	**7,73**	**0,02**	**Oxygen consuption VO_{2max} (ml/kg/min)**	1	2	-4,16	0,12
		3	**15,69**	**0,00**			3	**16,56**	**0,00**			3	**-6,69**	**0,00**
		4	**8,81**	**0,00**			4	**11,41**	**0,00**			4	**-5,45**	**0,02**
	2	1	**-7,37**	**0,02**		2	1	**-7,73**	**0,02**		2	1	4,16	0,12
		3	**8,32**	**0,00**			3	**8,83**	**0,00**			3	-2,54	0,32
		4	1,43	0,89			4	3,68	0,29			4	-1,29	0,82
	3	1	**-15,69**	**0,00**		3	1	**-16,56**	**0,00**		3	1	**6,69**	**0,00**
		2	**-8,32**	**0,00**			2	**-8,83**	**0,00**			2	2,54	0,32
		4	**-6,89**	**0,01**			4	**-5,15**	**0,06**			4	1,24	0,83
	4	1	**-8,81**	**0,00**		4	1	**-11,41**	**0,00**		4	1	**5,45**	**0,02**
		2	-1,43	0,89			2	-3,68	0,29			2	1,29	0,82
		3	**6,89**	**0,01**			3	**5,15**	**0,06**			3	-1,24	0,83

Legend: 1-goalkeepers, 2-defensive players, 3-midfielders, 4-attackers, p-level of statistical significance of univariate analysis of variance, TM-Body weight, TV-Body height, VO2max - Maximum oxygen consumption

The basic descriptive indicators of the morphological variables of this study showed that the average (BW) (182.07 cm) and (BH) (78.55 kg), and that they are similar to the results of the study (Suzić et al., 2004), whose mean values BW) are 182.7cm and (BH) 79.7kg. However, when it comes to the basic parameter of aerobic capacity, VO2max, the results of our research differ from the mentioned research. The average value of VO2max is 57.30 ml / kg / min is higher compared to the entire sample of their study (52.2 ml / kg / min). In both studies, the best aerobic abilities were shown by midfielders, and the worst results in abilities were achieved by goalkeepers.

The needs of goalkeepers for aerobic abilities are incomparably less than the needs of other players. However, goalkeepers need to possess enviable aerobic abilities that would allow them to have explosive jumps, quick reactions in the form of timely throws and reactions. The results of our research showed us that goalkeepers are taller than other players, and that their body weight is higher than other teammates. The average height of the goalkeeper is 192.39 cm, defensive players 184.66

cm, midfielders 175.82 cm, and attackers 180.97 cm. Body weight is the highest for goalkeepers (87.77 kg) and defensive players (80.40 kg), followed by attackers (78.97 kg), and the lowest for midfielders and is 72.08 kg.

There is a large body of research that has looked at assessing the functional abilities of footballers. Previous research on the functional abilities of team sports (Ostojić, 2000) has shown that the maximum oxygen consumption of top football players in Serbia is 53.5 ± 8.6 ml / kg / min, while these values range from 42.9 ± 6.6 ml / kg / min in lower-class footballers. The obtained values of VO2max in football players in our study (57.15 ± 5.21ml / kg / min) are much higher in relation to the values of lower-class and multi-class football players in Serbia of the mentioned research. Sporish et al. (2009) determined the average values of aerobic capacity indicators in elite Croatian football players VO2max (60.1ml / kg / min) and FSmax (189.1), which are higher than the football players of Serbian clubs. Đukić et al. (2016) dealt with the functional abilities of senior football players, in which the sample consisted of 47 senior football players, of which 21 football players aged 23.71 ± 4.22 years from a better placed club and 26 football players aged 21.46 ± 3 , 68 years old from a poorly placed club from the area of Vojvodina that competes in the Serbian Super League.

From the descriptive parameters, it can be seen that the values of relative maximum oxygen consumption (RVO2max), as the most important parameter for assessing aerobic energy capacity, are higher in footballers of a lower placed club (57.71 ml / kg / min) compared to a better placed team / kg / min), without this difference being statistically significant (p = 0.42). This parameter, as well as other indicators of aerobic energy capacity, do not differ in the level of significance (p <0.05), and indicate that the players who play for these clubs have very similar functional abilities. Equal abilities of football players in the researched variables are a consequence of similar training processes and equal playing experience and, finally, the age of athletes.

CONCLUSION

This paper presents the differences, ie similarities of some morphological characteristics and functional abilities that describe the football player in the team, ie their abilities and characteristics. The obtained results of maximum oxygen consumption indicated that there is a statistically significant difference in aerobic abilities between goalkeepers and players in other positions, and they are certainly a consequence of the physiological requirements placed before them and the different training process.

This paper attempts to point out the importance of diagnosing the basic indicators of functional abilities of football players that should serve as a starting point in compiling training plans and programs, while respecting the characteristics and characteristics of each individual. The results of our research confirm the obtained results of the research of Suzić et al. (2004) in which the order of values of functional abilities of players by positions is the same. The highest mean value of VO2 max had midfielders (53.3 ± 1.9 ml / kg / min), followed by attackers (52.9 ± 4.4 ml / kg / min), defensive players (51.8 ± 3, 3 ml / kg / min) while the lowest values were recorded in the goalkeeper (50.5 ± 1.8 ml / kg / min). There is a logical conclusion that the need for running midfielders is the greatest, and the goalkeeper the least, and that the results are the result of training processes and different requirements for individual positions in the team.

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