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ANTHROPOMETRIC AND BODY COMPOSITION DIFFERENCES AMONG ELITE MACEDONIAN`S SOCCER AND HANDBALL PLAYERS

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(Original scientific paper)

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Abstract

The comparative researches on athlete's anthropometric characteristics are undoubtedly important in modern sport, and they have been studied for a long time by a considerable number of sports scientists from many countries. However, only a few studies that address this topic have been conducted on Macedonian athletes. The present research was conducted on 181 elite players divided in two groups as follows: 91 handball players and 90 soccer players. The respondents were measured for their height, weight, diameters, volume and skinfolds; the body composition, somatotype components and BMI - index were indirectly calculated with the purpose of establishing their common morphological characteristics, and to analyzing the specificity, i.e. probable differences according to the sport. Breadth and girth values were evaluated by ANCOVA, and height and weight were used as co-variate factors. The other variables were rated by metric ANOVA. The research results suggest that the soccer players are shorter and have lower body weight as compared to handball players, their BMI is statistically considerably lower compared to that of handball players. Soccer players have higher relative girth of the lower extremities, and smaller values of all skinfolds and lesser percentage of the fat component as compared to the handball players. The mesomorphic component dominates in general with the soccer players, and their somatotype category is a balanced mesomorph, whereas the one-mesomorph type is obtained with handball players.

***Key words**: anthropometry, physical differences, somatotype, sports*

Introduction

Team's sports games are an ideal medium for satisfying basic human needs for mobility, collaboration and competition. They require of athletes a high level of physical, emotional and cognitive engagement in order to outplay and defeat the opponent. The so called defined success in collective sports depends on a number of external and internal factors (regarding the individual person), among which the anthropologic characteristics of players have a significant role. Undoubtedly, an important component of the anthropological characteristics are the anthropometric characteristics as well and they have been studied for a long time by sports scientists. It is a well-known fact that most of the anthropometric characteristics are genetically predisposed. It is very difficult to influence the longitudinal and transversal measures. (Norton, K., & Olds, T. 2001). However, the morphological structure has a direct impact on the athlete's performances, and, above all, they are important in planning an effective training program. Along with its correlation with sports performances, anthropometric status is also important to the sports coach in order to properly instruct young athletes for sports they best fit according to their personal anthropological profile. In addition, it is known that a number of ball sports games require certain variations in the morphological profile of the players keeping different pitch positions in the team (soccer, basketball, handball, volleyball, rugby etc.) (Hoare, 2000).

Studies on the physical characteristics of the human body to-date indicate that the morphological characteristics of athletes successful in a specific sport differ in somatic characteristics from the general

population. Tanner mentions that the absence of a proper body structure is bound to prevent the athlete from achieving top sports results. Carter, who had studied the body structure of top athletes from different competing ranks, points at the similarity of the body dimensions and constitution, and the similarity grows further with the rank – the higher the competition rank, the greater similarity is. According to this, the "sports type" is to be defined in the easiest way within a homogenous group of top athletes from a given sport (Larson & Macmillan, 1974). To be effective, training process must consider both the current and targeted anthropometric status of players, on the one hand, and the game specific demands and desirable results, on the other (Barr et al., 1994).

Though the number of comparative researches studying the athlete`s anthropometric characteristics is great, there are few studies in the Republic of North Macedonia treating that problem. Therefore, the present research was conducted – to describe the anthropometric characteristics, body composition and somatotype components of active elite Macedonian athletes from more sports games (basketball, handball and soccer) and to detect possible differences in relation to competition level.

Methods

Subjects

The research was conducted in the Laboratory of Functional Testing, Department of Physiology and Anthropology at the Medical Faculty in Skopje, where all the athletes from the Republic of North Macedonia must have a routine sports medical examination, regulated twice a year at least. The current investigation involved an analytic-comparative design to evaluate the anthropometric characteristics of top Macedonian athletes from more than one sport. The data from athletes who have played in the first national league and have undertaken routine sports medical examinations over the three year period (2016–2018) were analysed in this study. Prior to the initiation of the tests, the purpose and procedures were explained to all the athletes. Data were confidential and data protection was observed. The research was conducted on 181 top athletes, aged from 19 to 35. The respondents were divided into two (2) groups as follows: 91 handball players and 90 soccer players. The respondents were treated according to the Declaration of Helsinki.

Protocols and equipment

All measurements were conducted by a highly qualified, trained and skillful technicians. Body height and weight were measured by a stadiometer (Seca, Leicester, UK) and an electronic scale (HD-351, Tanita, Illinois, USA). The skinfolds were measured with the help of John Bull calipers. The girth measures were taken by the standard non-elastic measure track, while the diameters were taken by a caliper GPMc).

In addition to the height and weight, the following anthropometric measures were taken: four diameters (elbow, wrist, knee and ankle); five circumferences (upper arm, both relaxed and flexed, forearm, the calf and the thigh) as well as seven skinfolds (biceps, triceps, forearm, thigh, calf, subscapular and supra-iliac). Anthropometric parameters were analysed by a special software program that utilizes all Mateigka's formulas intended for calculations of all body components (Cattrysse, et al., 2002). Somatotyping components (endomorph – mesomorph - ectomorph) were calculated according to Carter and Heath method (1990), using the somatotype software (SomatotypeV.1.2.5).

Statistical analysis

The differences in body height, weight, BMI, skinfold thickness, body components, and somatotype components between the groups were tested by one way analysis of variance (ANOVA); and multiple comparisons between pairs of groups were carried out according to the LSD test. Breadth and girth measurements were compared by one-way analysis of co-variance (ANCOVA); and multiple comparisons between pairs of groups were carried out according to the LSD test. In this analysis, weight and height were controlled as co-variates. Statistical analysis was performed using the SPSS 22.0 for Windows (Statistical Package for the Social Sciences, version 22.0, SSPS Inc, Chicago, IL, USA).

Results

The assessment of table 1 shows that the soccer players are shorter and have lower body weight as compared to the handball players ($p<0.001$). Their BMI is statistically in a significantly lower proportion in comparison to that of the handball players ($p<0.001$).

The assessment in Table 2 shows that when body height and weight are controlled as a co-variance, no

statistically significant differences were found between handball and soccer players in any transversal anthropometric measurement. The handball players have a greater girth of the upper arm and forearm as compared to the soccer players ($p < 0.01$). The soccer players have a greater girth of the thigh as compared to that of the handball players ($p < 0.001$).

Table 1. Descriptive statistics for stature, body weight, and BMI

	Handball		Soccer		F	Sig.
	Mean	SD	Mean	SD		
Height	186,91	6,22	180,30	6,08	62,46	0,000
Weight	91,57	10,58	77,58	6,83	130,32	0,000
BMI	26,21	2,78	23,85	1,52	58,19	0,000

Table 2. Diameters and circumferences (mm) (mean ± standard deviation) of athletes.

	Handball		Soccer		F	Sig.
	Mean	SD	Mean	SD		
DIAMETERS						
Wrist	57,82	4,01	58,09	56,69	0,22	0,643
Elbow	84,80	6,32	84,34	81,67	0,30	0,584
Knee	104,26	6,32	105,31	103,04	1,67	0,198
Ankle	75,02	5,23	75,81	74,16	1,07	0,302
CIRCUMFERENCES						
Upper arm	313,73	26,39	305,11	19,83	9,36	0,003
Thigh	585,84	87,50	606,44	31,47	3,84	0,051
Forearm	286,32	20,68	278,26	16,06	10,80	0,001
Calf	388,32	28,61	392,94	23,05	1,89	0,171

Table 3. Individual skinfolds (mm) (mean ± standard deviation) of seven sites of athletes.

	Handball		Soccer		F	Sig.
	Mean	SD	Mean	SD		
Forearm	7,55	2,48	5,73	1,36	43,22	0,000
Triceps	10,71	3,82	7,92	2,57	39,00	0,000
Thigh	17,43	6,49	11,62	4,37	58,48	0,000
Subscapular	13,64	4,91	9,99	3,05	42,14	0,000
Calf	12,92	4,31	9,02	3,33	54,66	0,000
Supra-iliac	11,50	5,39	7,79	2,83	38,84	0,000

Table 4. Body composition of athletes. The mean and standard deviation of the fat, bone and muscle weights (kg) and percentages are shown.

	Handball		Soccer		F	Sig.
	Mean	SD	Mean	SD		
MMA	68,18	10,46	57,12	9,01	69,09	0,000
MM kg	49,98	7,74	42,27	5,13	73,04	0,000
BM kg	16,33	13,32	13,40	1,60	4,86	0,029
FM kg	16,66	6,48	11,01	3,39	62,46	0,000
MM%	54,58	5,56	54,40	3,47	0,08	0,785
BM%	17,90	14,50	17,31	1,71	0,17	0,683
FM%	16,56	2,53	14,52	1,48	51,07	0,000
LBM	76,24	7,66	66,29	5,61	117,00	0,000

The assessment of Table 3 shows that the soccer players have statistically significant lower values of all skinfolds compared to those of the handball players ($p < 0.001$).

The arithmetic mean values and the level of statistical significance in Table 4 show that the soccer players have statistically significant lower absolute values of the muscle, bone and fat component as compared to the handball players ($p < 0.05$). As for the percentage differences of the body composition component (Table 4), it can be seen that soccer players have smaller percentages of fat component compared to the handball players ($p < 0.001$). There are not established statistically significant differences between the handball and soccer players in the percentage values of the bone and muscle component.

The assessment in Table 5 shows that statistically the average values of the mesomorphic and endomorphic components (components related to total muscle mass and fat component) are significantly higher in handball players compared to those with footballers ($p < 0.001$). The high values of the endomorphic and mesomorphic component reflect the excellent body structure of the handball players. As would be expected, the average values of the ectomorphic component are significantly lower for handball players than for footballers. ($p < 0.001$).

Table 5. Scores (mean ± standard deviation) of the three components of the somatotype

	Handball		Soccer		F	Sig.
	Mean	SD	Mean	SD		
Endomorph	3,3	1,2	2,4	0,7	52,68	0,000
Mesomorph	6,0	1,4	5,4	1,0	15,47	0,000
Ectomorph	2,0	0,9	2,4	0,7	19,93	0,000

Discussion

The former researches show that morphological characteristics and body composition can be influential in selecting athletes in many sports (Hasan et al., 2007; Ziv and Lidor, 2009). The results of the research suggest the importance of differences in anthropometric characteristics, body composition and somatotypes' components between athletes from different sports when estimating absolute values. But the authors of the present study think that the estimation of anthropometric characteristics (after having controlled the height and weight) provide more relevant results regarding the morphologic body structure (Pelin, et al., 2009).

During the research, the anthropometric characteristics, body composition and somatotype components of the active Macedonian elite athletes from several sports (handball and football) were studied, and the obtained data are compared with each other. The soccer players are shorter and have lower body weight and index of body mass (BMI) compared to the handball players. The average body height of Macedonian adult soccer players is 180 cm, while the body mass is 77.6 kg. Different studies show that soccer players in national and international competitions vary in their body weight, height and BMI index depending on the geographic location, ethnic and cultural influences or different soccer styles, diet habits etc. The professional and/or elite soccer players in Europe, the Middle East and South America have the average body height which vary from 176.0 – 183.0 cm, and weight which is generally less than <80 kg (in a span of 65.6 – 78.7 kg) and BMI index varying between 23.00-24.45 kg/m². The average value of the body height, body mass and BMI index of the Macedonian soccer players is greater compared to the players from Asian teams, and the values are similar with those of the players from European and South American teams (Bandyopadhyay, 2007; Reeves, et al., 1999; Chin, et al., 1992; Pluncevic G. et al., 2014). Comparing the morphological characteristics between the Macedonian soccer players and those from the neighboring countries (Croatia and Serbia) it can be seen that Macedonian soccer players have nearly identical height and weight with those playing in Croatia and Serbia (77.6 kg and 77.4 kg) (Ostojic, 2000 , Matkovic, et al., 2003).

Handball players have a high BMI index compared to the soccer players. These differences can be ascribed to the differences in the game structure and regulations which are specific for the game of handball. The inspection of the obtained data reveals that Macedonian handball players have lower body height compared to the European players in the World Cup competition 2013. For example, the average height of the Spanish winner-team was 193 cm., Danish – 194 cm., Croatian – 194, while the Korean players had the average height of 187 cm, and Kuwait – 184 cm. (Ghobadi, et al., 2013). The Africa and Asia teams

have shorter players in comparison with the European ones (Taborski, 2007).

Statistically significant differences were not established in the relative transversal anthropometric measures between the soccer and handball players. Soccer players have also greater relative girth of the thigh compared to the handball players. This could be pre-anticipated if it is kept in view that soccer players use only the lower extremities, which take the most load, whereas handball players use both the upper and lower extremities.

The research results suggest further that soccer players have significantly lower values of the all skinfolds, and smaller percentage of the fat component as compared to that of the handball players. Between the soccer and football players there were not established differences in the percentage values of the bone and muscular component. These results are expected mainly because a number of previous studies have found that the aerobic component in the energy supply is dominant in soccer (Kemi et al., 2003;. Ukradeni et al., 2005.), while the anaerobic component in the energy supply is dominant in sprints, jumps and duels, which is an element on which the success of the game mostly depends. (Sporish et al., 2008).

On the other hand, it is the anaerobe component of supplying energy that dominates in handball (20% to 25% aerobic activity and 75% to 80% anaerobic activity) (Brittenham, 1996). These results are expected also due to the fact that the handball competition lasts 60 minutes and is divided in two half-times of 30 minutes each: whereas the soccer competition takes 90 minutes divided into two half-times of 45 minutes each. During the competition handball plyers run a distance from 2.000 to about 6.000 meters (Popovich et al, 2012), whereas the soccer player runs the distance of 10.000 to about 12.000 meters (Dellal et al., 2010). These differences can be explained by the specifics and structures of the handball game that provides a lot of contact with opposing players, fighting for a better position, activities accompanied by pushing, opposing, swirling- in a word, great physical intensity in very short and dynamic activities, and the relatively large total body mass allows handball players to perform these tasks.

The amount of the fat component in the body is important from the physiological view, the bigger fat percentage in the body being in correlation with the athlete's physical predispositions, especially in those activities with which the body or particular parts of the body move in the space [Gil, et al., 2007]. The percentage of the fat component with the Macedonian soccer players ranges about 14%, and with the handball players about 16%. The average values of the body fat percentage in our study population were found at the higher zone of the optimal level (5–15%) delineated by Heyward and Wagner (Heyward & Wagner, 2004) for a physically active male population.

The mesomorph component dominates as general in the soccer players, and their somatotype category is a balanced mesomorph (Mathur et al., 1985; Apor, 1988; White et al., 1988; Casajús and Aragonés, 1991; Ramadan and Byrd, 1991; Rienzi et al., 2000; Casajús, 2001; Bandyopadhyay, 2007; Rahmawati et al., 2007). The Macedonian soccer players of this research have similar somatotype characteristics like elite players from the other countries. Somatotype of the Portuguese players of the First League is 2.8-5.6-2.2 (Gomes et al., 1989) (cited by Casajús, 2001), the Spanish National Team (1990 World Cup) 2.2-5.1-1.9 (Casajús and Aragonés, 1991), top level Hungarian 2.1-5.1-2.3 (Apor, 1988), and elite level South American players 2.2-5.4-2.2 (Rienzi et al., 2000) were higher than the mesomorph score obtained in the our study.

For handball players, it turned out to be a common athletic type of mesomorph with a pronounced longitudinal dimension of the skeleton, an equal proportion of bone and muscle tissue and slightly higher values of adipose tissue and endomorphic component.

Conclusion

In the descriptive studies in sport, body structure is most commonly determined on the base of absolute anthropometric values. In this study, the height and weight are controlled by one-direction analysis of covariance (ANCOVA), aiming to establish the morphologic characteristics in a more valid way. The results of the study show that the soccer players are shorter and have lower body weight as compared to that of the handball players, their BMI is statistically significant lower compared to that of the handball players. Soccer players have lower values of all skinfolds and smaller percentage of the fat component in comparison with the handball players. The mesomorphic component generally dominates in football players, and their somatotype category is balanced mesomorphic, while in handball players the single - mesomorphic type is obtained. Our results show that the selection of players in particular sports must be based on the morphologic characteristics of the players. Coaches should have a good knowledge of the

general and specific tasks that the player should perform in the game. The obtained results can be used as normative anthropometric indexes for the routine sports medical examinations of the elite athletes in our country. The data can be also used as a model for comparison of anthropometric and somatotype data of elite athletes from different countries.

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