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Body Composition Assessment in Young Bulgarian Tennis Athletes

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A B S T R A C T

Body composition is a major factor determining achievements in racket sports (tennis, table tennis and squash) and plays a significant role in the level of physical development. The aim of the present study is to assess body composition in young Bulgarian tennis players. A total of 86 boys (26 tennis players, 60 schoolchildren), aged 10-11 years, participated in this cross-sectional study. Body composition was determined by means of multi-frequency bioelectrical impedance measurements (BIA). The following anthropometric indices were calculated: fat mass index (FMI=fat mass/ stature^2, kg/ m^2), fat free mass index (FFMI= fat free mass/ stature^2, kg/m^2). Comparisons between groups were performed by Student t-test ($P< 0.05$). Relationships between anthropometric features and training experience of tennis players were assessed by Pearson's correlation. Tennis players (TP) had significantly lower weight, body mass index, body fat and percent body fat compared to non-tennis players (NTP). The mean values of FMI in TP were 3.08 ± 1.42 kg/ m^2 and they were lower than these in untrained controls (4.99 ± 2.99 kg/m^2). The average values of FFMI in the investigated groups were equal ($P>0.05$). In athlete they were 14.12± 0.98 kg/m^2 and in non-athlete – 14.30 ± 1.04 kg/ m^2. Training experience of TP was significantly and negatively correlated with several anthropometric traits and indices of body composition. Physical activity, particular tennis training was inversely correlated with body weight, body fat and FMI, moderately correlated with FFM in children.

Key words: *BIA, Body composition, fat-free mass index, fat mass index, tennis players*

Introduction

Body composition is an important part of the morphological characteristics of children and adolescents. During the intensive growing up and developmental periods, and also in the adult ages its compartments undergo significant age and sexual differences reflecting the genetic factors, mainly expressed in the proportions of body fat (BF) and active body mass (ATM). This fact makes them important indicators in tracing the changes in physical status and body constitution of man and in some cases for man's health status. These changes have been influenced by external factors as socio-economic conditions, nutrition, work activity, sport activity and etc.

Several researchers established that supporting optimal levels of body composition characteristic in athletes is associated with improvements in cardiovascular respiratory function[2, 8] and strengths[7,17]. However, changes in body composition compartments can lead to health problems in individuals with low body mass mostly associated with dehydration in prolonged and intense exercise[12]. Body composition among athletes has been shown to be a function of the physical task and is varied across different types of athletes [6, 24]. However, an increase in body fat (BF) has been shown to decrease performance[23].

Therefore, anthropometric characteristics and body composition are a major factor determining achievements in racket sports (tennis, table tennis and squash) and play an important role in reaching optimal performance in many other sports[21].

Body mass index (BMI) is the most popular method to define the level of obesity. However the limitations of BMI have been recognized for many years, because it does not provide the information about the independent contributions of fat mass (FM) and fat free mass (FFM) which vary according to height, weight and age. Because of those researches has indicated that assessing of body composition is a primary determinant of health [16], and a better predictor of morbidity and mortality risk than BMI [5, 20]. Studies have emphasized the importance of determining body fat and FFM by direct measures, rather than relying on the body mass index (BMI) when describing obesity or

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malnutrition risks [20]. The application of fat free mass (FFMI) and fat mass (FMI) indexes in anthropological research eliminates differences in these parameters due to height and enable us to make more precise assessment.

The aim of the present study was (1) to assess body composition in young Bulgarian tennis players, and to (2) elucidate potential correlations between body composition compartments and physical activity in young athletes.

Materials and Methods

Subjects

This is a part of a complex anthropometric assessment of tennis players (TP) and non-tennis players (NTP) aged from 9 to 16 during field research in 2016 – 2018. A total of 86 boys (26 tennis players, 60 schoolchildren), aged 10-11 years, participated in the current cross-sectional study. All boys and their parents volunteered for the research and gave their written informed consent. The study protocol was reviewed and approved by the Human Ethical Committee of Institute of Experimental Morphology, Pathology and Anthropology with Museum – Bulgarian Academy of Sciences (Protocol № 3/11.04.2018) and conducted in accordance with the declaration of Helsinki for human studies of the World Medical Association[25]. Tennis players (TP) completed a questionnaire regarding their training experience (TE) and all of them had trained tennis at least for 2 years. Group of NTP includes schoolchildren from two primary schools in Sofia, Bulgaria, who were not active in any sport.

Anthropometric measurements and BIA

The stature was measured to the nearest 0.1 cm (by Martin- Saller`s anthropometric method) and the boys were dressed in light clothing and were wearing no shoes during the study. Body mass and composition compartments were determined by means of multi-frequency bioelectrical impedance measurements, which were taken with the use of InBody (model: 170) analyzer with eight electrodes, which is characterized with high accuracy. The bioelectrical impedance analysis (BIA) is an instrumental method which is used to track changes in the body composition. The method is validated and gives reliable information for the nutritive status of healthy people as well as for patients with different diseases. BIA is based on the electrical properties of the tissue (conductivity and resistance). The resistance of the human body is closely related to total body water, which is in turn closely related to FFM. The measurement results are based on the input data for: gender, age, height[14].

Calculation of BMI, FFM and FM indexes

The following anthropometric indices were calculated:

Fat mass index (FMI) = fat mass/ stature^2, (kg/ m^2),

Fat free mass index (FFMI) = fat free mass/ stature^2, (kg/m^2).

The indexes are equivalent concepts to the BMI as mathematically, BMI (kg/ m^2) = FFMI (kg/ m^2) +FMI (kg/ m^2).

Statistics

Distribution normality of each variable was checked. The statistical analysis was made by Statistical SPSS 16.0 software package. Comparisons between groups were performed by Student t-test ($P< 0.05$). Relationships between anthropometric features and training experience of tennis players were assessed by Pearson's correlation analysis.

Results

Data for basic anthropometric and body composition features (mean; SD) were collected (Table. 1). Tennis players (TP) had significantly lower weight, body mass index, body fat and percent body fat compared to non-tennis players (NTP). Mean BMI value was in the normal weight status. Even though, one TP was classified as overweight, two of them as thin Grade I, while the rest were all in the

TABLE 1
ANTHROPOMETRIC AND BODY COMPOSITION CHARACTERISTICS IN TENNIS PLAYERS AND NON-TENNIS PLAYERS

Participants	Tennis players (n=26)		Non-tennis players (n=60)		P-value
	Mean	(SD)	Mean	(SD)	
Weight (kg)	37.25	(7.36)	41.53	(9.31)	0.026*
Stature (cm)	147.00	(7.09)	146.00	(6.52)	0.880
BMI (kg/m^7)	17.23	(2.25)	19.29	(3.66)	0.002*
PBF (%)	17.33	(5.29)	24.10	(10.13)	0.0001*
FM (kg)	6.72	(3.46)	10.80	(6.65)	0.0001*
FFM (kg)	30.52	(4.58)	30.74	(3.99)	0.835

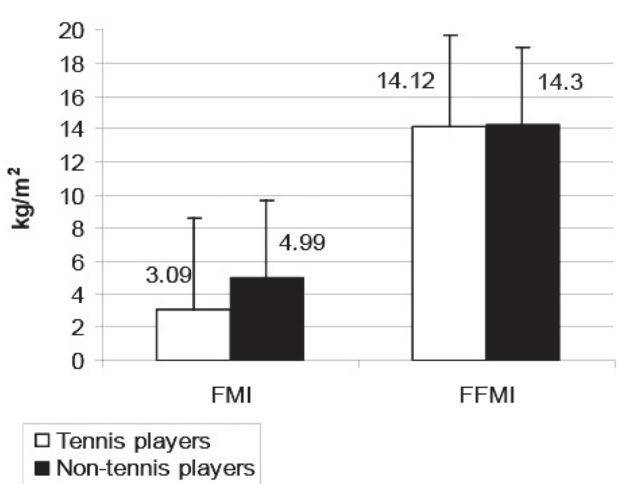

Fig. 1 Fat mass and fat-free mass index.

TABLE 2
PERCENTILE VALUES FOR FFM AND FM INDEXES IN TENNIS PLAYERS AND NON-TENNIS PLAYERS.

Percentiles Indexes	P10		P25		P50		P75		P90		P95	
	TP	NTP	TP	NTP	TP	NTP	TP	NTP	TP	NTP	TP	NTP
FFMI (kg/m^2)	12.90	13.16	13.24	13.38	14.13	14.24	14.75	14.94	15.74	15.69	16.05	16.31
FMI (kg/m^2)	1.70	1.88	2.14	2.64	2.84	4.24	3.45	6.85	4.94	9.56	7.13	10.90

normal weight category. In NTP group 12 boys were overweight, 4 were thin Grade I and 43 were in normal weight category [4]. There were significant differences in the mean values of FMI between TP (3.08 ± 1.42 kg/ m^2) and untrained controls (4.99 ± 2.99 kg/m^2). The average values of FFMI in the investigated groups were equal (P>0.05). In athletes they were 14.12± 0.98 kg/m^2 and in non-athletes – 14.30 ± 1.04 kg/ m^2 (Figure1). In the present study percentile values for FFM and FM indexes in Bulgarian adolescent tennis players, which had not been published so far, were shown (Table 2). The correlation coefficients between training experience of TP and their anthropometric and body composition features were presented in Table 3. A high level of significance was found for correlation between almost all anthropometric traits and indices of body composition excluding height. The training experience of TP was significantly and negatively correlated with weight and fat mass; moderately and negatively correlated with other traita excluding height (Table 3).

Discussion

Assessing body composition in the athletic field plays an important role in monitoring athletic performance and training outcomes as well as the health status of the athlete. This study characterized the changes that occur in body composition of young tennis players following their exercise training. Relative to standard cut- off values, TP had lower weight, body mass index, body fat and percent body fat as compared to NTP [4]. Our results confirm the importance of determining body fat and lean body mass FFM by direct measures, rather than relying on the body mass index (BMI) when describing anthropometric characteristics in athletes [18]. There are number of papers in the scientific literature which present a set of recommended ranges of FFMI and FMI for general population [1,9, 10, 11, 15, 22]. The use of these indexes derived in an analogous way to BMI, has been proposed as an alternative to BMI when estimates of FFM or FM are available. Fat mass (FM) and fat-free mass (FFM) are often used to identify nutritional requirements and energy expenditure of athletes [3]. According to Table 1, there were significant differences in the values of FM (kg) and percent body fat between both groups. The values were lower in tennis players' group and we can conclude that body weight decreases because of the reduction in FM. Physical activity has influence on muscle mass as a result of increased energy expenditure and helps maintain lean mass, bone mineral density, and body weight. The values of FFM were similar in both groups with slight prevalence in NTP group. It is due to the fact that the young tennis players' total energy expenditure exceeds their total energy intake.

It is well known that sport is an important factor that regulates body mass of children, which associated with higher obesity [19]. The results of the present study confirm our hypothesis that physical activity, particularly tennis training may be useful as a preventive method of youth overweight and obesity. Percentile values for FFM and FM indexes were created which were not previously defined for school children and young tennis players in Bulgaria. In athlete group where PBF has low value, a high BMI can be considered an index of large muscle

TABLE 3
CORRELATION BETWEEN TRAINING EXPERIENCES OF TP AND ASSESSED ANTHROPOMETRIC AND BODY COMPOSITION TRAITS.

Traits	Height	Weight	BMI	Fat mass	FFM	PBF	FMI	FFMI	TE
Height	1	0.796**	0.449*	0.478*	0.920**	0.274	0.331	0.585**	–0.344
Weight		1	0.891**	0.888**	0.938**	0.743**	0.806**	0.888**	–0.532*
BMI			1	0.950**	0.716**	0.898**	0.942**	0.901**	–0.467
Fat mass				1	0.674**	0.948**	0.984**	0.764**	–0.524*
FFM					1	0.479*	0.554**	0.853**	–0.447
PBF						1	0.983**	0.643**	–0.413
FMI							1	0.716**	–0.459
FFMI								1	–0.463
TE									1

** Statistical significant differences at p<0.01;
* Statistical significant differences at p<0.05;

mass. Sports nutrition experts can use these values to help develop specific dietary interventions, while athletic trainers can use body composition values to help create, optimize and evaluate training programs.

The correlation analysis showed that physical activity, particularly tennis training, was inversely correlated with body weight, body fat and FMI, and moderately and negatively correlated with FFM in other children. Coaches and sport scientists can use data about tennis players' characteristics to help them realize their personal potential. However, further studies are needed to develop new anthropometric models for young tennis athletes.

Conclusions

– Tennis players had significantly lower weight, body mass index, body fat and percent body fat compared to non-tennis players;

– New percentile values for FFM and FM indexes were created which had not been previously defined for young tennis players and school children in Bulgaria;

– Training experience of TP was significantly and negatively correlated with weight and fat mass; and moderately and negatively correlated with the other assessed traits excluding height.

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Disclosure statement

No potential conflict of interests.

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PROCJENA TJELESNE MASE U MLADIH BUGARSKIH TENISAČA

S A Ž E T A K

Tjelesni sastav je jedan od glavnih čimbenika koji utječu na postignuće rezultata u sportovima s reketom (tenis, stolni tenis i squash) i ima važnu ulogu u razini tjelesnog razvoja. Cilj ovog istraživanja je procjena tjelesnog sastava u mladih bugarskih tenisača. Ukupno 86 dječaka (26 igrača tenisa i 60 školske djece), u dobi od 10-11 godina sudjelovalo je u ovoj transverzalnoj studiji. Tjelesni sastav određen je metodom višefrekvencijske bioelektrične impedancije (BIA). Određeni su antropometrijski pokazatelji masnog tkiva (FMI=masno tkivo/ visina^2, kg/ m^2) i nemasne tjelesne mase (FFMI= nemasno tkivo/ visina^2, kg/m^2). Skupine su međusobno uspoređene pomoću t-testa, a odnosi između antropometrijskih obilježja i razine utreniranosti u tenisača određeni su Pearsonovom korelacijom. Dječaci koji se bave tenisom (TP) imali su značajno nižu tjelesnu težinu, indeks tjelesne mase, masno tkivo i postotak masnog tkiva u odnosu na dječake koji nisu igrali tenis (NTP). Srednje vrijednosti indeksa masnog tkiva u tenisača (3.08 ± 1.42 kg/ m^2) bile su niže od onih u kontrolnoj skupini koja nije trenirala tenis (4.99 ± 2.99 kg/m2)**.** Srednje vrijednosti indeksa nemasne tjelesne mase bile su iste u obje skupine (P>0.05), a iznosile su 14.12± 0.98 kg/m2 u tenisača i 14.30 ± 1.04 kg/ m^2 u kontrolnoj skupini. Fizička aktivnost, a osobito iskustvo treninga u tenisača, bila je značajno negativno povezana s nekoliko antropometrijskih obilježja indeksa tjelesne mase: tjelesnom težinom, masnim tkivom i FMI, dok je u ostale djece umjereno korelirala s FFMI.