

# Effect of Sports Training on Morphological Characteristics of Bulgarian Female Tennis Players

Albena Dimitrova<sup>1</sup>, Ivaila Ivanova-Pandourska<sup>1</sup>

<sup>1</sup> Institute of Experimental Morphology, Pathology, and Anthropology with Museum, Bulgarian Academy of Sciences, Sofia, Bulgaria

**Corresponding author:** Albena Dimitrova, Institute of Experimental Morphology, Pathology and Anthropology with Museum, Bulgarian Academy of Sciences, 25 Acad. Georgi Bonchev Blvd., Sofia, Bulgaria; Email: albena\_84@abv.bg; Tel.: +359 895 736 299

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## Abstract

**Introduction:** The intensity of tennis training together with specific exercises may be reflected in the morphological profile of tennis players.

**Aim:** To evaluate the impact of sports training on the body composition of female tennis players in the 11–13-year competition category.

**Materials and methods:** The study included an experimental group of 27 female tennis players (mean age 12.43±0.91 years) and 115 schoolgirls (mean age 12.55±0.88 years) as a control group. The following features were investigated: body height, body weight, body mass index, waist-to-hip ratio, muscle mass, fat mass, fat-free mass, percentage of body fat, total body water. The visceral adipose tissue and subcutaneous adipose tissue were computed using the Brambilla's equation.

**Results:** In comparison with the control group, tennis players have higher values of muscle mass ( $p<0.04$ ), total body water ( $p<0.05$ ), fat-free mass ( $p<0.04$ ) and lower values of body fat percentage ( $p<0.04$ ). The rest of the parameters were not found to have statistically significant differences.

**Conclusions:** We conclude that sports training influences some morphological parameters of female tennis players.

## Keywords

body composition, female, schoolgirls, tennis athletes

## INTRODUCTION

The assessment of anthropometric profiles of athletes aims to determine a specific morphology for each sport. It can be a crucial tool in relating body structure to talent identification and sports success. Athletes are a selected group of people who systematically endure a significant physical load which leads to differentiation of body composition compartments in regards to sport discipline.<sup>[1-3]</sup> The changes in body composition may lead to dehydration and health problems in athletes with low body weight.<sup>[4,5]</sup>

On the other hand, the increase of body fat has been shown to decrease sports performance.<sup>[6,7]</sup>

Tennis is a sport which has become very popular in Bulgaria and all over the world in the last decades. The intensity of tennis training together with some specific exercises should be reflected on the morphological profile of tennis players.<sup>[8]</sup> Supporting optimal levels of body composition characteristic in young athletes is necessary for reaching optimal performance and good health.

## AIM

The aim of the present study was to evaluate the impact of sports training on the body composition of female tennis players in the 11-13-year competition category.

## MATERIALS AND METHODS

The present study included an experimental group of 27 female tennis players (mean age  $12.43 \pm 0.91$  years) and 115 girls (mean age  $12.55 \pm 0.88$  years) as controls. All girls and their parents gave their written informed consent and participated voluntarily in the study. The study protocol was reviewed and approved by the Human Ethics Committee of the Institute of Experimental Morphology, Pathology and Anthropology with Museum with the Bulgarian Academy of Sciences (No. 3/11.04.2018) and conducted in accordance with the declaration of Helsinki for human studies as developed by the World Medical Association.<sup>[9]</sup> All tennis players (TP) included in the study had trained in tennis for at least 2 years, for no less than 12 hours a week. The group of non-tennis players (NTP) included schoolchildren from some primary schools in Sofia, Bulgaria, who were not active in any sport.

We investigated the following features: body height (BH), body weight (BW), body mass index (BMI), waist-to-hip ratio (WHR), muscle mass (MM), fat mass (FM), fat-free mass (FFM), percentage body fat (PBF), and total body water (TBW). The stature was measured to the nearest 0.1 cm (using Martin-Saller's anthropometric method). The girls 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 using an eight-electrode InBody (model: 170) analyzer which is characterized with high accuracy. The bioelectrical impedance analysis (BIA) is an instrumental method that is used to track the changes in the body composition. The method is validated and gives reliable information for the nutritive status of individuals, especially in athletes. 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 closely related to FFM. The measurement results are based on the input data for gender, age, height.<sup>[10]</sup> All girls were classified into three weight categories (normal, overweight, thin Grade I) according to Cole's normative BMI values.<sup>[11]</sup> PBF of the participants was determined according to Houtkooper PBF cut-offs for children.<sup>[12]</sup> Visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT) were computed by Brambilla's (2006) equations:

$$\text{VAT (cm}^2\text{)} = 1.1 \times \text{WC (cm)} - 52.9$$

$$\text{SAT (cm}^2\text{)} = 23.2 \times \text{BMI (kg/m}^2\text{)} - 329$$

Statistical analysis was performed using SPSS 16.00 for Windows. The Student's t-test was applied to compare the variable means, and statistical significance was defined as  $p < 0.05$ .

## RESULTS

The mean values of height in female tennis players and school girls were  $158 \pm 7.75$  cm and  $156 \pm 7.25$  cm, respectively. There were no significant differences between the average height of 11-13-year-old athletes and non-athletes girls ( $p = 0.35$ ) (Fig. 1).

All assessed girls were in the normal weight category for the age 11-13 years; statistical non-significant differences were observed between TP and schoolgirls ( $p = 0.554$ ).

Body composition analysis (mean; SD) showed that female tennis players had significantly higher muscle mass ( $p = 0.04$ ), fat free mass ( $p = 0.037$ ), and total body water ( $p = 0.045$ ) compared to control group (Table 1).

Data for basic obesity parameters (BMI, PBF, WHR) were collected (Table 2). The average values of BMI and WHR in the two investigated groups were equal ( $p > 0.05$ ). According to the BMI cut-offs, the highest percentage of girls who played tennis were classified with normal weight (50.8%), 27.0% of them with underweight Grade I, and 22.2% with overweight. In the NTP group, 46.9% of the

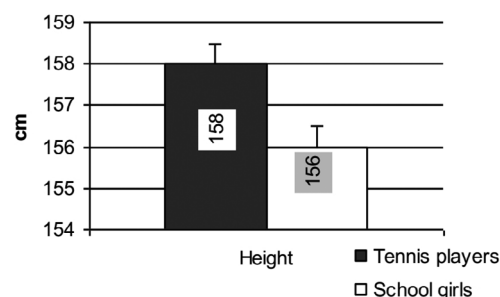


Figure 1. Height in 11-13-year-old female tennis players.

Table 1. Body composition analysis in 11-13-year-old female tennis players and schoolgirls

Traits	Tennis players (n=27)	School girls (n= 115)	Significance
Weight (kg)	49.32±9.05	48.11±11.06	0.554
Muscle mass (kg)	20.46±3.69	18.82±3.28	0.040*
Fat mass (kg)	10.70±4.31	12.76±7.00	0.160
Fat free mass (kg)	38.06±6.25	35.18±6.17	0.037*
Total body water (l)	27.90±4.58	25.91±4.00	0.045*

\* Statistical significant differences at  $p < 0.05$

**Table 2.** Obesity analysis in 11-13-year-old female tennis players and schoolgirls

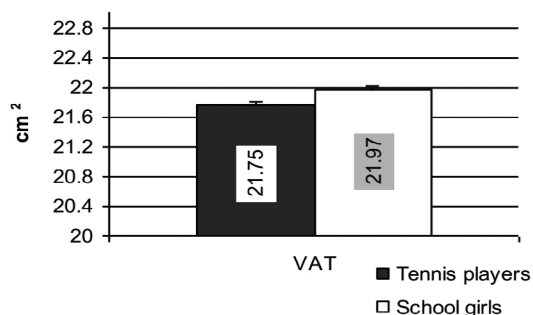
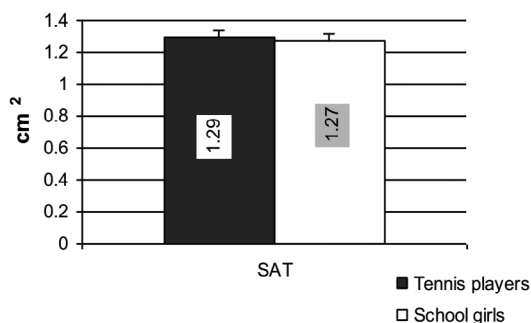
Traits	Tennis players (n=27)	School girls (n= 115)	Significance
BMI (kg/cm <sup>2</sup> )	19.72±2.22	19.64±3.67	0.885
PBF (%)	22.32±6.01	25.19±7.66	0.040*
WHR (cm)	0.79±0.97	0.79±0.44	0.510

\* Statistical significant differences at  $p < 0.05$

girls were found to have normal weight, 32.2% with underweight Grade I and 20.9% were overweight.

One of the most important and well-studied anthropometric features in athletes is the percentage of body fat. Body fat percentage is influenced mainly by age and the athlete's sports level. The mean PBF values of TP were 22.32±6.01%, while these values for untrained controls were significantly higher by 2.87% ( $p=0.04$ ) and they were 25.19±7.66%. According to Houtkooper PBF cut-offs for children, TP had optimal PBF values (16-25%), compared with an untrained control group where they were at the borderline between the optimal and moderately high (26%-30%) levels (Table 2).

Means and standard deviations for VAT and SAT are shown in Figs 2, 3. The mean values for VAT were 21.75±7.97 cm<sup>2</sup> in the TP group and 21.97±9.50 cm<sup>2</sup> in the NTP group. The mean values of SAT in both groups were equal (1.29±5.16 cm<sup>2</sup> and 1.27±8.53 cm<sup>2</sup>, respectively).

**Figure 2.** Visceral adipose tissue in 11-13-year-old female tennis players.**Figure 3.** Subcutaneous adipose tissue in 11-13-year-old female tennis players.

## DISCUSSION

In the present study, the comparative analysis among young competitive TP and the schoolgirls who are not engaged in any sports, was provided to evaluate the differences in their anthropometric and body composition parameters, as well as the impact of sports training on the body composition profile in the 11-13-year old TP. BIA techniques have become very popular in the recent years for estimating body composition profile in athletic populations because it is rapid, non-invasive, and inexpensive.<sup>[13-16]</sup> Applying the multi-frequency impedance method, some authors found that body mass index (BMI) and body fat percentage (PBF) in tennis players had higher values than athletes practicing other sports.<sup>[17,18]</sup> Regarding the anthropometric characteristics of female TP, similar values were found by Gualdi-Russo et al. They determined the sex-related differences in body composition in young Italian tennis players, expressed in better musculoskeletal development of boys and higher fat distribution in girls (11.6%), with the greatest accumulation of SAT on upper and lower extremities. Contrary to our results (27.90±4.58 l), the authors established lower mean values for TBW (10.2 l) in female TP.<sup>[18]</sup> Using BIA, Attlee et al. determined the mean values of TBW 28.6±8.2 l and mean values of lean body mass 21.7±1.6 kg, which were close to our results.<sup>[17]</sup> Shluga and Filho reported greater values than our values for lean body mass in 11-15-year-old tennis players (37 kg).<sup>[19]</sup> Berdejo-del-Fresno et al. conducted a longitudinal study that included body composition and fitness profile in elite TP during a whole season using dual-energy X-ray absorptiometry.<sup>[20]</sup> The authors found that the subjects increased significantly their height, lean percentage, and bone percentage and decreased significantly the abdominal fat percentage. Comparing our sample with these results, Bulgarian TP girls were 6 cm taller and 8 kg heavier, than the Spanish tennis players. Regarding the PBF and BMI, our results were similar. Close to our results for PBF in young female tennis players (22.32±6.01%) were obtained by Kibler et al., for 14-19-year-old female tennis players in highly competitive athletic levels (21-23%).<sup>[21]</sup> The most recent studies documented 19-21% mean values of PBF in junior female TP and these values tend to decrease slightly when the player improves their game through training experience.<sup>[22-24]</sup> Comparing our data with the prescriptive values for TBW, FM, PBF, and FFM for 12-19-year-old children estimated by Chumlea et al. we got similar results.<sup>[25]</sup>

Commonly, high values of waist circumference in children were associated with a higher risk of obesity-related diseases (cardiovascular and endocrine disorders, type 2 diabetes) in adult age. It is well known, there is a close relationship between some anthropometric features and visceral (VAT) and subcutaneous adipose tissues (SAT). Brambilla et al. found such relation and noted that waist circumference (WC) can be considered as a good predictor of VAT as well as BMI of SAT.<sup>[26]</sup> Based on the results of the present study VAT and SAT did not vary among the female TP and untrained controls.

## CONCLUSIONS

We provide for the first time a whole-body composition analysis by BIA in young Bulgarian female TP aged 11-13 years. We conclude that sport activity influences the morphological characteristic of female tennis players expressed with higher values of MM ( $p<0.04$ ), TBW ( $p<0.05$ ), FFM ( $p<0.04$ ), and lower values of PBF ( $p<0.04$ ) compared with the control group.

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# Влияние спортивной подготовки на морфологические характеристики болгарских теннисисток

Албена Димитрова<sup>1</sup>, Ивайла Иванова-Пандурска<sup>1</sup>

*<sup>1</sup> Институт экспериментальной морфологии, патологии и антропологии с музеем, Болгарская академия наук, София, Болгария*

**Адрес для корреспонденции:** Албена Димитрова, Институт экспериментальной морфологии, патологии и антропологии с музеем, Болгарская академия наук, бул. „Акад. Георги Бончев“ № 25, София, Болгария; Email: albena\_84@abv.bg; Тел.: +359 895 736 299

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## Резюме

**Введение:** Интенсивность теннисных тренировок вместе с конкретными упражнениями может отражаться на морфологическом профиле теннисистов.

**Цель:** Оценить влияние спортивных тренировок на состав тела теннисисток в соревновательной категории 11–13 лет.

**Материалы и методы:** В исследование были включены 27 теннисисток (средний возраст  $12.43 \pm 0.91$  года) и 115 школьниц (средний возраст  $12.55 \pm 0.88$  года) в качестве контрольной группы. Исследовались следующие признаки: рост, масса тела, индекс массы тела, соотношение талии и бёдер, мышечная масса, жировая масса, безжировая масса, процент жира в организме, общая вода тела. Висцеральную жировую ткань и подкожную жировую ткань рассчитывали по уравнению Brambilla.

**Результаты:** По сравнению с контрольной группой теннисисты имеют более высокие значения мышечной массы ( $p < 0.04$ ), общей воды тела ( $p < 0.05$ ), безжировой массы ( $p < 0.04$ ) и более низкие значения процентного содержания жира в организме ( $p < 0.04$ ). По остальным параметрам статистически значимых различий обнаружено не было.

**Заключение:** Сделан вывод о влиянии спортивной подготовки на некоторые морфологические параметры теннисисток.

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## Ключевые слова

состав тела, девушки, школьницы, теннисистки

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