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Asymmetry of Lean Body Mass Accumulation in 12-year-old Tennis Players. (Preliminary Results)

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Tennis is a sport characterized by high physical activity and frequently repeated motions, especially for the dominant upper limb. This creates differences between upper limbs and lead to an asymmetric distribution of muscle mass and unbalanced muscle tonus.

The aim of the study is to estimate the degree of muscle mass asymmetry between the dominant and non-dominant limbs in young Bulgarian tennis players, using multi-frequency bioelectrical impedance measurements. The study sample includes 14 male tennis players and 11 school children aged 12 years. Segmental analysis of body composition was done by bioelectrical impedance analyzer (model: InBody 170). The athletes have a larger muscle mass of the dominant upper limb compared to the non-dominant. The non-athlete boys are characterized with lower asymmetry coefficient level of the upper limbs' muscle mass compared to the tennis players ($p < 0.05$). The significant relationship between asymmetry coefficients of the upper limbs, mean age and years of training experience in tennis players are not found.

Key words: asymmetry, bioelectrical impedance, muscle mass, body composition, Bulgarian tennis players

Introduction

Both genetic potential and optimal environmental factors contribute to achieving a high level of sport performance. Therefore the interest of scientists to anthropometric characteristic and body composition of athletes from different competitive sports increased over the last decades [9]. But sports participation not only positively influences anthropometric features like body weight, body composition and particularly body symmetry [6, 10]. Tennis is a sport characterized by high physical activity and frequently repeated motions, especially for the dominant upper limb. This creates differences between upper limbs [4] and lead to an asymmetric distribution of muscle mass and unbalanced muscle tonus [1]. Training experiences of tennis players also creates anatomical differences between dominant (DA) and non-dominant (NDA) upper limbs and leads to an asymmetry in the muscle mass distribution [8, 11, 12, 13].

The aim of the study is to estimate the degree of muscle mass asymmetry between the dominant and non-dominant upper limb in young tennis players, using multi-frequency bioelectrical impedance measurements.

Materials and Methods

The study sample included 14 male tennis players (TP) represented a high sport class in tennis clubs in Sofia, Bulgaria. The athletes' mean age was 12 ± 0.38 years, and the length of their training experience: 5 ± 2.51 years.

The control group (NTP) included 11 boys aged 12.51 ± 0.34 years from a middle school from Sofia, Bulgaria. All participants and their parents gave written informed consent (in conformity with the Helsinki Declaration) and voluntarily to fill out a questionnaire for handedness/footedness. Questions in the study regarding functional asymmetry of the boys were summarized in **Table 1**. Eleven athletes played tennis with the right arm and three of them with the left arm. Nine of the non-athlete boys declared being right-handed and two of them were left-handed. Body height was measured using standard procedure to the nearest 0.1cm. Body weight and body composition, along with segmental distribution of muscle and fat mass were determined by bioelectrical impedance analyzer InBody 170 with eight electrodes, which characterized by high precision and accuracy [7]. The bioimpedance analysis (BIA) is widely used method, relatively inexpensive and noninvasive [3, 9]. Segmental body composition analysis allows rapidly and easily determination of asymmetry in the accumulation of lean and fat mass [5, 12].

The data of muscle mass on the right and left arm, right and left leg were analyzed. Asymmetry coefficients of muscle mass accumulation in the upper (AA) and lower (AL) limbs were calculated by Wolanski equation (1957) [15]:

$$WAE = (xd - xnd) / ((xd + xnd) / 2) \cdot 100\% ,$$

where:

Xd – muscle mass on the dominant side [kg];

Xnd – muscle mass on the non-dominant side [kg].

The data from present study were analyzed by statistical software package SPSS 16.0 (SPSS Inc, Chicago, IL, USA). Student's t-test was applied to compare variable means and statistical significance was defined as $P < 0.05$.

Correlation analysis was used for the assessment of relationships between asymmetry coefficients of the upper limbs and mean age and years of training experience in TP (**Table 1**).

Table 1. Questionnaire of handedness and footedness in athlete and non-athlete boys

	Questions
Handedness	Which hand does subject used to draw or write?
	Which hand does subject used to hold a tennis racket?
	Which hand does subject used to cut with scissors?
	Which hand does subject used to hold a dynamometer?
Footedness	Which leg does subject used to kick a ball?
	Which leg does subject used to leap forward to cover a selected distances?
	Which leg does subject used to make the longest jump?

Results and Discussion

The results for height and weight are similar for both groups. The tennis players' mean body height is 162.00 ± 7.06 cm and their mean body weight is 51.46 ± 7.24 kg. In control group of non athlete boys the average body height is 160.00 ± 6.33 cm and body weight - 50.40 ± 8.72 kg.

The segmental analysis of body composition shows that tennis players have larger muscle mass of the dominant upper limb compared with non-dominant. The asymmetry coefficient is high (7.1 %) but statistically significant differences are not observed. Similar results are found for muscle mass distribution of the lower limbs in the same group, but the level of asymmetry is low - 0.57%, only. Significant differences with regard to muscle mass distribution between the dominant and non-dominant upper and lower limbs in controls are not revealed, (asymmetry's level is 3.33% and 1.14%, respectively).

Muscle mass in the upper and lower limbs is also compared between the tennis players and the control group. Significant differences are observed between these groups in terms of the dominant and non-dominant upper limb (**Table 2**).

The relationships between age, training experience and AA in tennis players are assessed by correlation analysis. A positive and moderate relation between age and training experience and a negative and weak one between age and AA of tennis players exist but association between training experience and AA in the same group is not observed (**Table 3**). The established correlations are not significant ($P > 0.05$).

Many researches proved that morphological asymmetry exists in athletes [4, 6, 11, 12]. Some of the studies used a high-technology based methods such as magnetic resonance imaging (MRI), dual-energy X-ray absorptiometry (DEXA), but they are too expensive, time-consuming and cannot be utilized in field experiments [2, 13, 14]. The current study applied BIA to assess the body composition and differences in muscle mass distribution of the upper limbs as a result of sporting activity. In tennis players training experience leads to increased asymmetry in the fat free mass in the arms. The

Table 2. Mean values of measured characteristics and statistical significance between studied groups

Characteristics	Groups		Significance
	TP (n=14)	NTP (n=11)	D: TP-NTP
DA (kg)	2.15±0.48	1.73±0.44	2.1*
NDA (kg)	2.01±0.49	1.68±0.43	1.65
AA (%)	7.10±4.07	3.33±2.1	0.43
T:DA-NDA	p= 0.7	p= 0.25	
DL (kg)	6.56±1.14	6.15±0.98	1.05
NDL(kg)	6.53±1.15	6.09±0.97	1.05
AL (%)	0.57±0.46	1.14±0.57	-0.15
T:DL-NDL	p= 0.07	p= 0.14	

TP - tennis players; NTP - non-tennis players; D: TP-NTP - statistically significant differences at $P < 0.05$ between specified groups; DA - dominant upper limb muscle mass; NDA - non-dominant upper limb muscle mass; AA - asymmetry coefficient of upper limbs; T: DA-NDA - statistically significant differences at $P < 0.05$ between the upper limbs; DL - dominant lower limb muscle mass; NDL - non-dominant lower limb muscle mass; AL - asymmetry coefficient of lower limbs; T:DL- NDL - statistically significant differences at $P < 0.05$ between the lower limbs.

Table 3. Correlation between asymmetry coefficient of the upper limbs, mean age and years of training experience in tennis players

Characteristics		Age	Years of training experience	Asymmetry coefficient
Age	Pearson Correlation	**1**	0.544	– 0.287
	Sig. (2-tailed)		0.163	0.392
Years of training experience	Pearson Correlation		**1**	0.099
	Sig. (2-tailed)			0.816
Asymmetry coefficient	Pearson Correlation			**1**
	Sig. (2-tailed)			

level of asymmetry in athletes corresponds to 7.10%, contrary to non-athletes where the asymmetry's value is only 3.33%. Although our values of asymmetry of upper limbs are lower in comparison with professional tennis players, but they are higher than those observed in Polish tennis players (4.06%) [12]. Sanchis-Moysi et al. determined the volume of the muscle mass of the upper limbs using MRI in 11-year-old boys practicing tennis. The authors concluded that tennis participation five times a week, in time before puberty is associated with muscle hypertrophy of the dominant upper limb, leading to a high level of asymmetry (13%) [13].

Our preliminary study shows that the muscle mass of upper and lower limbs are dominant on the right side in both groups. The value of asymmetry of the lower limb is much lower than this of the upper limb (**Table 2**). These values are similar to Polish tennis players, but they are lower than those of Polish schoolchildren [12]. Although the relationship between age, training experience and asymmetry coefficient values are not significant we consider that sport training revealed an influence on asymmetry in muscle mass distribution in the upper limbs.

Conclusion

Based on our preliminary results we can conclude that the method of bioelectrical impedance can be used to easy determination of muscle mass asymmetry in the limbs. Tennis players have high level of muscle mass asymmetry between the dominant and non-dominant upper limbs. The control group are characterized by lower muscle mass asymmetry coefficient of the upper limbs than the tennis players ($p < 0.05$). The muscle mass of upper and lower limbs are dominant on the right side in assessed groups, but asymmetry value of the lower limb is much lower than this of the upper limb. There are no significant relationships between asymmetry coefficients of the upper limbs, mean age and years of training experience in tennis players' group.

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