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Comparative study of segmental and whole-body composition in male tennis players and CrossFit athletes

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The present investigation includes 87 male middle-aged athletes (54 CrossFit and 33 tennis players). Body composition assessment was performed using bioelectrical impedance measurements (InBody 170 analyzer). The whole-body analysis includes body weight, body mass index, muscle mass, fat mass, fat-free mass, and total body water. The segmental distribution of muscle and fat mass (in kg and percentage) was also presented. Descriptive statistics were generated using SPSS 16 (IBM, USA), and the distribution of normality was assessed. The independent samples t-test was used to evaluate the differences in body composition. Significant differences in whole-body composition were observed for the relative values of muscle mass, with a particular emphasis on TP. A significant prevalence of fat mass values was observed among CF practitioners. Segmental analysis of body composition showed a significantly higher muscle mass of the lower limbs in the TP group and of the fat mass in all body segments of CF.

Key words: CrossFit, Tennis players, Body composition, Segmental analysis

Introduction

Body composition analysis (BC) is a method used for measurement of different components of human body, like fat mass, muscle mass, bone density, and water content. Its values are important determinants for health conditions and sports performance [3,11,20]. It is used to track changes in body composition components, and to create personalized fitness and nutrition plans. The constantly changing conditions of life (stress, sedentary lifestyle and insufficient physical activity, changes in eating habits, etc.) lead to changes in the components of body composition, with the most variability in the adipose tissue [7]. Segmental analysis of body composition provides additional information to the usual full- body analysis. Different studies have found a close association between body composition and cardio-respiratory function and strength

[6,9]. Body composition components differ among athletes participating in different sports, such as those in the same sport who occupy different playing positions [16].

In recent years, CrossFit training has been gaining increasing popularity worldwide. CrossFit (CF) is a high-intensity workout that combines both aerobic and anaerobic types of exercises, like gymnastics, jumping, running, and weightlifting. The CF athletes demonstrate a good anaerobic performance, expressed in maximum peak power that their body can generate for short-duration maximal effort. In sports BC components have a significant impact on the athlete`s performance. It is well known, that the first main component of BC – body fat, has a negative effect on sports success. Contrary to that the muscle mass and lean body mass, may positively affect the performance especially in sports with explosive power requirements [5,8,15,21,26].

Tennis is sport that requires a good explosive strength for optimal sports results. Like a CrossFit training tennis training also require aerobic and anaerobic endurance. Muscle and fat mass have a significant impact on the tennis athlete`s performance. In tennis, strength, speed and flexibility are crucial components for sports success, which correlate significantly with the muscle mass. Well-developed muscles mass particularly in the legs and upper body parts are essential for explosive movements, quick changes of direction, and overall tennis performance. On the other hand, a high percentage of body fat can negatively influence tennis players` agility and speed, and slow down overall mobility and reaction time on the court, and also can increase the risk of injuries [10,23].

The current study aimed to present a comparative analysis of segmental and whole-body composition between male tennis players and CrossFit athletes.

Materials and Methods

The present investigation includes 87 male athletes (54 CrossFit and 33 tennis players). The mean age of the tennis players (TP) and CrossFit athletes was 38.61±7.66 years and 39.56±6.39 years, respectively. All of the athletes are amateurs at the sport they practice, with a mean training experience of CF athletes 3.77±2.43 years and 5.68±3.62 years in TP. All of the participants are informed of the objective of the current study and voluntarily participate in it. The study protocol was reviewed and approved by the Ethical Committee of the National Sports Academy (Protocol №: EC-NSA-2025-001/08.04.2025) and was conducted in agreement with the principles stated in the Declaration of Helsinki for human studies and researches [24]. Body composition assessment was performed using bioelectrical impedance measurements (InBody 170 analyzer). The whole-body analysis includes body weight (BW), body mass index (BMI), muscle mass (MM), fat mass (FM), fat-free mass (FFM), and total body water (TBW). The segmental distribution of muscle and fat mass (in kg and percentage) was also presented. Descriptive statistics were generated using SPSS 16 (IBM, USA), and the distribution of normality was assessed (Shapiro-Wilk). The independent samples t-test was used to evaluate the differences in body composition.

Results

Descriptive statistics for whole-body composition in CF athletes and TP were presented in **Table 1**. Comparative analysis of the basic morphological characteristics showed that TP are taller than CF athletes, who are heavier and have higher body mass index (BMI) values. The mean values of body height are 183.62±5.35 cm in TP and 177.66±6.86 cm in CF athletes. The mean body weight is insignificantly higher in CF practitioners (83.56±10.02 kg) compared with TP (80.15±10.34 kg). The average values of BMI in CrossFit athletes were 26.47 ±2.80 kg/m^2, which were significantly higher than those of tennis players' 23.73±2.46 kg/m^2. According to the mean BMI values, we categorized TP as having a normal weight and CF athletes as having an overweight status. The higher BMI in CF practitioners is due to the higher values of muscle mass, and it would be wrong to associate them with overweight and obesity.

Significant differences in whole-body composition also were observed for the relative values of muscle mass, with a particular emphasis on tennis players ($p \leq 0.001$). The percent of muscle mass was 46.63±3.30% in CF athletes and 49.09±3.21% in TP. The average absolute values (in kilograms) of muscle mass (MM), fat-free mass (FFM) and total body water (TBW) in the two investigated groups were equal ($p \geq 0.05$). A significant prevalence of both absolute and relative fat mass values was observed among CrossFit practitioners ($p \leq 0.001$). The mean relative body fat values of TP were 13.97±5.43%, while these values for CF athletes were significantly higher by 4.21% ($p \leq 0.001$) and they were 18.17±5.43%. According to the absolute fat mass values, CF has 4.75 kg morefat mass than TP.

Table 1. Whole-body composition analysis in male CrossFit athletes and tennis players

Traits	CrossFit athletes (n=54)	Tennis players (n=33)	P-value
Age (y)	39.56±6.39	38.61±7.66	0.732
Body height (cm)	177.66±6.79	183.62±5.35	0.001
Body weight (kg)	83.56±10.02	80.15±10.34	0.132
BMI (kg/m^2)	26.47±2.80	23.73±2.46	0.001
Muscle mass (%)	46.63±3.30	49.09±3.22	0.001
Muscle mass (kg)	38.89±4.79	39.28±5.22	0.722
Fat mass (%)	18.18±5.66	13.97±5.43	0.001
Fat mass (kg)	16.10±6.89	11.35±5.22	0.001
Total body water (L)	50.28±6.19	50.41±6.45	0.930
Fat free mass (kg)	68.21±8.12	68.82±8.80	0.744

Segmental analysis of muscle mass (%, kg) and fat mass (%, kg) was presented in **Fig. 1** to **Fig. 4**. A significantly higher percentage of muscle mass of the lower limbs ($p \leq 0.004$; $p \leq 0.001$) in the TP group was obtained. Opposite to these results the absolute and relative values of fat mass have a great prevalence for all body segments in CF athletes ($p \leq 0.005$; $p \leq 0.001$).

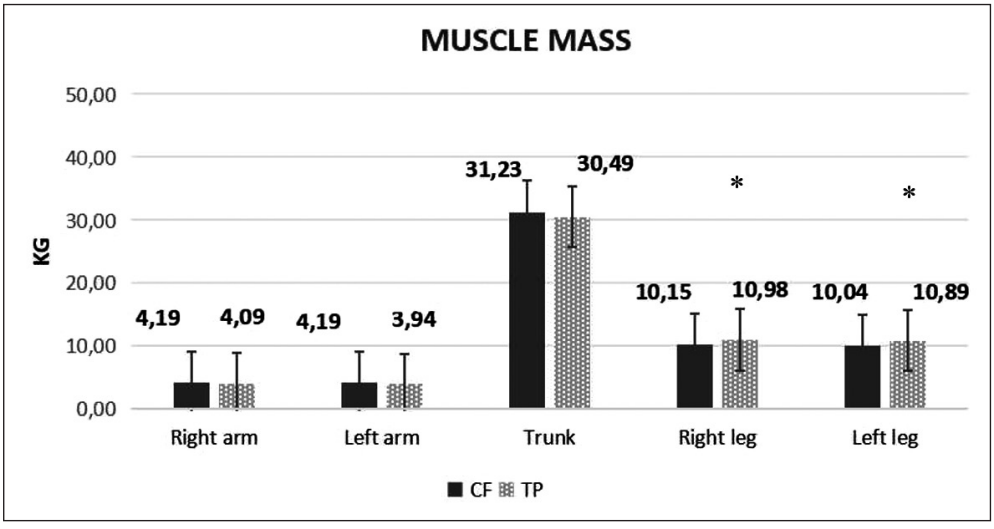

Fig. 1. Segmental distribution of absolute values of muscle mass in tennis players and Cross-Fit athletes.

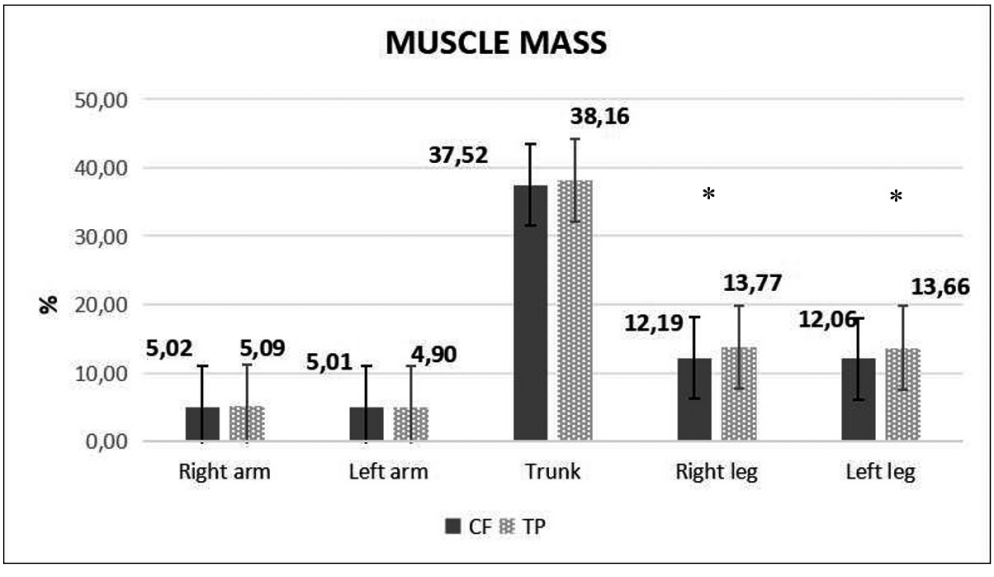

Fig. 2. Segmental distribution of relative values of muscle mass in tennis players and Cross-Fit athletes.

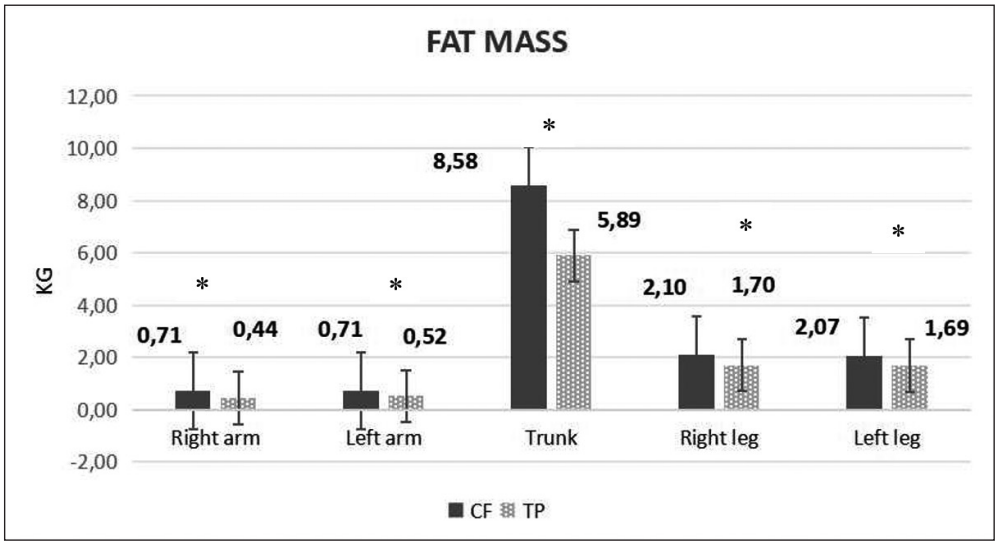

Fig. 3. Segmental distribution of absolute values of fat mass in tennis players and CrossFit athletes.

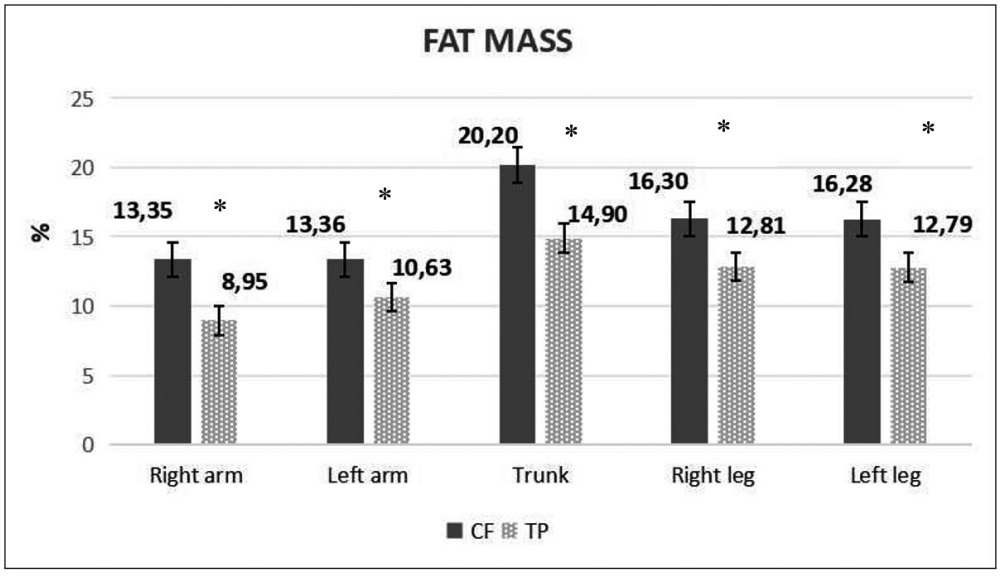

Fig. 4. Segmental distribution of relative values of fat mass in tennis players and CrossFit athletes.

Discussion

The current study presents comparative results for segmental and whole-body analysis in athletes who practice two different sports, with both aerobic and anaerobic performance.

Tennis players and CrossFit athletes exhibit distinct body composition characteristics due to the differing demands of their respective sports. The results from the current study indicate that TP have a higher percentage of muscle mass and lower body fat, while CrossFit athletes have a higher body fat percentage but potentially lower muscle mass in comparison to tennis players. Assessing the relation between whole-body and segmental body composition and anaerobic performance Ponce-Garcia et al. (2024) create a prediction model for optimal performance in CrossFit athletes. The authors found a moderate relationship between muscle and fat mass development in all body parts and anaerobic performance. Segmental and total lean mass distribution may be considered as good predictors of peak and mean power [15]. Tennis is an explosive sport training that has a very high requirement for the endurance of athletes. The fitness level and the muscle mass of the upper and lower limbs have a great impact on the TP performance on the court [10,23]. The morphological profile of tennis players is formed during adolescence, as shown by the study of Rica et al. (2019), which declared similar to our results for BC in TP athletes. The study distinguished typical morphological traits in adolescent TP as follow: normal BMI, low PBF and higher values of muscle mass, especially in the upper arms [17].

Segmental body composition analysis evaluates the distribution of muscle mass, fat mass, and other body tissues across different body segments (e.g., arms, legs, trunk). This analysis can help to optimize sports training, identify potential injury risks, improve performance and maintain overall athletic health [2,18]. Segmental analysis reveals that CF athletes and TP tend to have a greater proportion of muscle mass in their limbs and trunk compared to the general population, which can be advantageous for the diverse movements and demands of sports modality [4]. The distribution of muscle mass is not uniform. The legs, particularly the thighs, are crucial for power and agility in tennis. Analysis can reveal differences in muscle mass and fat distribution that may affect performance [17,19]. The trunk muscles are vital for generating power and stability. Analysis can help identify imbalances that could affect serve speed or overall core strength [2,22]. The diverse nature of CrossFit workouts often leads to increased muscle mass across different body segments. CrossFit athletes, especially those with higher performance levels, tend to have significantly higher muscle mass in their arms and legs and trunk compared to less active individuals [13]. Considering that CF workout significantly improves aerobic endurance, anaerobic endurance and explosive power, Wang and Yao (2023) assessed the effect of CF training on tennis players' performance. They declared significant improvement on backhand and forehand strokes and increasing of the overall performance level of tennis [25].

Conversely, higher fat mass in the same segments is negatively associated with performance, highlighting the importance of optimizing fat distribution [14]. CrossFit athletes generally maintain a low body fat percentage, which is beneficial for exercises and overall performance [4,13]. An investigation of BC in CF athletes showed an average PBF for men and women 11.60 % and 15.23 %, respectively [4]. The results we get for male CF athletes are significantly higher (18.18 %). Competitive male tennis players typically maintain a low body fat percentage, generally fewer than 12%. While the ideal body fat percentage can vary slightly, a range of 6-12% is generally considered optimal for male tennis players. According to the results of Martinez-Rodriguez et al. (2015) the mean PBF in adult male TP is 16.2 %, which is significantly different from our results (13.97 %) [12].

The body composition of tennis players and CrossFit athletes reflects the unique demands of their respective sports. While both groups prioritize high muscle mass, tennis players may place a greater emphasis on lean muscle for agility and speed, while CrossFit athletes focus on overall muscle development for strength and power.

Conclusion

The current study confirms the great prevalence of muscle mass accumulation in the lower limbs in TP group in comparison with CF athletes and equal values in the upper body parts between groups. The comparative analysis of body composition in the TP and the CF provides new insights into both assessed sports populations and could serve as a basis for the development of specific reference values in future investigations.

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