BODY COMPOSITION OF THE SERBIAN NATIONAL TRACK AND FIELD TEAM

TELESNA KOMPOZICIJA ČLANOVA ATLETSKE REPREZENTACIJE SRBIJE

Anita ŠOLAJA¹, Andrijana MILANKOV²,³, Sladana PEJAKOVIĆ²,³ and Edita STOKIĆ²,³

Summary

Introduction. The performance in athletics depends on various anthropometric factors as well as on the training process. The body fat percentage and running speed during the training sessions are the most important factors for running success.

Material and Methods. The study included 61 athletes, members of the Serbian senior national track and field team. Nine morphological characteristics were measured and the sum of skinfolds, body density, body fat percentage and body mass index were calculated. Results. A one-way ANOVA showed a statistical significance between the height (F = 2.97; p = 0.03), weight (F = 7.00; p = 0.00), sum of skinfolds (F = 4.30; p = 0.01), body density (F = 4.09; p = 0.01), percentage of body fat (F = 4.02; p = 0.01), body mass index (F = 3.86; p = 0.01), and the athletic disciplines. The female athletes showed a statistically significant difference between height (F = 3.54; p = 0.03), weight (F = 3.70; p = 0.03) and body mass index (F = 5.40; p = 0.01) related to disciplines. Of all the disciplines, the percentage of body fat was the highest in male throwers (10.10±3.61) and female sprinters (15.82±3.06).

Conclusion. The male and female athletes of the Serbian national track and field team showed higher sums of skinfolds compared to top athletes and members of more successful national teams. However, it is possible to increase the loss of body fat and indirectly improve the athletic performance with adequate education of coaches and athletes, and application of other, more precise body composition measurement methods.

Key words: Body Composition; Athletes; Anthropometry; Body Fat Distribution; Body Mass Index; Skinfold Thickness; Sports

Sažetak

Uvod. Performanse u atletici su pod uticajem različitih antropometrijskih faktora kao i faktora u trenirnom procesu. Kao najvažniji faktor uspešnosti u trčanju, pored brzine trčanja tokom trenirnog procesa, izolovao se procenat masne mase u organizmu. Materiaj i metode. Istraživanje je realizovano na 61 ispitivanih, članovima seniorske nacionalne atletske selekcije. Izmerno je 9 morfoloških karakteristika i izračunati su suma kožnih nabora, telesni denzitet, procenat masne mase i indeks telesne mase. Rezultati. One-way ANOVA je pokazala statističku značajnost između visine (F = 2,97; p = 0.03), mase (F = 7, p = 0.00), sume kožnih nabora (F = 4,30; p = 0.01), telesnog denziteta (F = 4,09; p = 0.01), procenta masne mase (F = 4,02; p = 0.01) kao i indeksa telesne mase (F = 3,86; p = 0.01) i disciplina kod atletičara. Kod atletičarki je utvrđena statistički značajna razlika između visine (F = 3,54; p = 0.03), mase (F = 3,70; p = 0.03), indeksa telesne mase (F = 5,40; p = 0.01) i disciplina kod atletičara. Od svih disciplina, procenat telesne masti je najveći kod bacača (10,10 ± 3,61) i sprinterki (15,82 ± 3,06). Zatvaranje. Kako je kod atletičara i atletičarki nacionalne selekcije, utvrđena veća suma kožnih nabora u odnosu na vrhunsko atletičarke drugih, uspešnijih nacionalnih selekcija, uz odgovarajuću edukaciju trenera i atletičara, ali i korisnjenjem drugih, preciznijih metoda procene kompozicije tela, moguće je povećati gubitke telesnih masti u organizmu i indirektno poboljšati učinak na terenu.

Ključne reči: telesna kompozicija; sportisti; antropometrija; distribucija masnog tkiva; indeks telesna mase; debljina kožnog nabora; sport

Introduction

The assessment of body composition gives an insight into the ratio between fat and lean mass in the human body. Fat tissue is widespread and made up of essential fat tissue (metabolically active) and fat storage tissue, which protects the organs of the abdomen and thorax. The assessment of body composition practically means the body fat percentage (BFP). The percentage of essential fat is higher in women (8–12% of the total body fat mass) than in men (3–5% of the total body fat mass) and it is considered the minimum for normal functioning of the organism, recommended by the National Academy of Sports Medicine (NASM) [1]. Any percentage of fat higher than recommended leads to health damage and development of numerous complications. Determination of the body composition or BFP is a key factor in the assessment of body health [2–5], but it is also useful in monitoring the potential effects of the training process and the health status in young athletes [6, 7]. Some anthropometric characteristics of individual athletes are believed to be an important determinant of success in sport [8]. Track and field performance depends on various factors as well as anthropometric factors in the training process [9].

Original study

University of Novi Sad, Faculty of Sport and Physical Education, Novi Sad¹
University of Novi Sad, Faculty of Medicine, Novi Sad
Department of Internal Medicine²
Clinical Center of Vojvodina, Novi Sad
Clinic of Endocrinology, Diabetes and Metabolic Diseases³

Originalni naučni rad
UDK 572.512:613.25:796.4.071
DOI: 10.2298/MPNS1704087S

对应作者：Mr sc. Anita Šolaja, Fakultet sporta i fizičke kulture, 21000 Novi Sad, Lovčenska 16, E-mail: anitasolaja@yahoo.com
In the literature we have surveyed, the sum of skin the same number of skinfolds \( [6–8, 16, 17, 20–22] \). The running performance is affected by the body weight \( [25] \), BMI \( [18, 26, 27] \) and the BFP \( [28, 29] \), besides the skinfolds and their sums.

The objective of this study was to assess the body composition of male and female athletes of the senior Serbian national track and field team, and determine differences in body composition in regard to athletic disciplines.

**Material and Methods**

The study included 35 men and 26 women, members of the senior track and field team of Serbia. The examinees were 19 to 33 years old (mean age 22.87±3.39). The study was conducted during the preparation of the official track and field team of Serbia in Bar (Montenegro), in April 2015, in accordance with the Declaration of Helsinki and with the approval of the competent Ethics Committee. The coaches and athletes were given a detailed explanation of the purpose of the research, the methods used, as well as the benefits and potential risks. All participants entered the study voluntarily. Those who refused to participate, athletes under the age of 18 years, those who were injured and who had not trained in the preceding three months, were not included in the study.

Among the male participants, 13 were sprinters, 5 were middle and long distance runners, 7 jumpers, 5 throwers and 5 decathlon athletes. As for the female participants, 14 were sprinters, 4 were middle and long distance runners, 6 jumpers and 2 throwers.

One of the inclusion criteria was at least two years of active competition at national and international levels. All athletes trained six to seven days a week, from two to four hours a day during the competition season, and they did not train for less than a month during each year. No changes were made in regard to the quantity or quality of the food they consumed.

The measurements were conducted in the morning hours. The instruments were standard, and their accuracy was checked and calibration performed before each measurement; the same person measured all anthropometric features, thus reducing the possibility of measurement errors.

Regarding morphological characteristics, the body height was measured for the evaluation of longitudinal dimensionality of the skeleton, and body weight, triceps skinfold, subscapular skinfold, chest skinfold, midaxillary skinfold, abdominal skinfold, suprailium skinfold and the thigh skinfold were measured for the evaluation of volume and body weight.

The body height was measured using “Martin” (SECA GmbH& Co., Hamburg, Germany) anthropometer with the accuracy of 1 mm. The body weight was measured using digital scales TANITA UM-72 (Body Composition Monitor Tanita Corp., Tokyo, Japan) with the accuracy of 0.1 kg. The skinfold data were obtained by using “John Bull” (CMS instruments, London, UK) calipers with the accuracy of 0.1 mm. The pressure on the tips of calipers was checked according to the manufacturer's instructions. The calipers were checked all anthropometric features, thus reducing the possibility of measurement errors.

**Abbreviations**

- BFP – body fat percentage
- BF – body fat
- BMI – body mass index
- LSD – least significant difference

Morphological characteristics, such as skinfold thickness, BFP, limb girth and length, body weight, body height, and body mass index (BMI), have an impact on athletic performance, especially in running. The BFP has been identified as the most important factor for the running success, apart from the running speed during the training process \( [10] \).

Hetland et al. have shown that the regional and total body fat are inversely proportional to performance in runners \( [11] \), especially in the disciplines where the body leaves the ground (jumping), or it is in rapid acceleration above the ground (sprinting and hurdling), and where there are specific relations with the body height, fat tissue, lean weight components, the volume of the extremities and the lower limb girth \( [12] \).

The body fat can be determined in the following ways: by measuring the thickness of skinfolds and subcutaneous fat with calipers, since the BFP can be calculated due to the interaction between the specific gravity of the body and skinfold thickness in the specific places (above the biceps, triceps, below the blades and above the pelvis on the right side); by bioelectrical impedance analysis; electrical impedance, or opposition to the flow of an electric current through body tissues, which can then be used to estimate total body water, fat-free body mass, and body fat. Dual-energy x-ray absorptiometry is a technique using ionizing radiation through the body and recording the turn and attenuation of the received signal over the entire body or individual segments. In addition to the above, other methods can be applied, such as the method of hydrodensitometry, computed tomography of the body composition, quantitative magnetic resonance imaging and near infrared interactance \( [13, 14] \).

The measurement of anthropometric parameters and skinfold thickness is the simplest method; it does not require expensive equipment and specially trained personnel, and the results are obtained immediately, so the connection with the running performance can be intensively studied \( [15, 16] \).

Arrese and Ostariz (2006) found a high positive correlation between the skinfold thickness of the lower extremities and the running speed in several racing disciplines from sprinting to middle and long distance running. These morphological features may be useful predictors of athletic performance \( [17] \). The sum of skinfold thickness was identified as an important predictor variable for running success, apart from the skinfolds which are measured separately \( [15, 18] \). However, in various studies the sum of skinfolds does not always include the same individual skinfolds or the same number of skinfolds \( [6–8, 10, 16, 18, 20–25] \). In the literature we have surveyed, the sum of skinfolds consisted mainly of the sum of seven to ten folds which included the upper body and lower body heights \( [6–8, 16, 17, 20–22] \). The running performance is affected by the body weight \( [25] \), BMI \( [18, 26, 27] \) and the BFP \( [28, 29] \), besides the skinfolds and their sums.
cording to the manufacturer’s specifications and it was constant at 10 g/mm². Reading the results was carried out two seconds after achieving this pressure [30, 31]. The measurements were carried out three times on the right side of the body [30–32] and the mean value of three measurements was used for data analysis. The measurements were performed according to the method of the International Biological Program (IBP) [33].

To measure a skinfold, the skin was pinched by the left hand, with the thumb pointed downward, and the back of the hand was in full view of the person who performed the measurement. To raise the skinfold, the measurer used the thumb and index finger of the left hand to pinch the fold of a double layer of both adipose tissue and skin. In order to eliminate the muscle, the finger and thumb rolled the fold slightly, thereby also ensuring that there was a sufficiently large grasp of the fold. The near edges of the finger and thumb, in line with and straddling the landmark, raised the fold in the direction specified for each site. The calipers were held in the right hand with the fingers operating the movable arm. A full sweep of the needle was 20 mm, and this was reflected on the small scale on the caliper face. The calipers were applied to the fold so that there was 1 cm between the near edge of the fingers and the nearest edge of the caliper face. The reading of the dial to 0.1 mm was made 2 seconds after the complete release of the caliper trigger [32].

The body composition was assessed in each examinee using the technique of skinfolds, where the values of body density (g/cm³) were obtained by means of the Jackson-Pollock equation (Jackson Pollock-7-site skinfold formula for body density) based on the sum of seven skinfolds [30]. The obtained values of body density were then converted to Siri equation, by which the percentage of body fat was calculated (% BF), while the value of the BMI (kg/m²) of athletes was calculated as the ratio of body weight and height [31]. The obtained values were expressed as mean values both for male and female participants, as well as an average value of the above parameters of anthropometric characteristics for each group of track and field disciplines.

Data were processed by statistical package SPSS 20 (Statistical Package for the Social Sciences, V.20; SPSS Inc, Chicago, Illinois, USA). Distribution normality was tested by Shapiro-Wilk test.

Data analysis included the calculation of descriptive statistics of variables: arithmetic mean (M) and standard deviation (SD) value of the measurement results. The differences between the tested variables in relation to the track and field discipline of respondents were identified with one-way analysis of variance - ANOVA, including the least significant difference (LSD) Post Hoc test. Statistical significance was set at p <0.05.

**Results**

The distribution normality was confirmed by the Shapiro-Wilk test for all variables analyzed in the study. Table 1 shows the mean and standard deviation values for each tested variable, separately in relation to sex, for all participants. A wide range of results was observed for body height and body mass in the participants of both sexes, which is in accordance with a great number of track and field disciplines. On average, male participants had a lower sum skinfold thickness and BFP compared to women, while the body density and BMI were higher than average (Table 1).

The results of one-way ANOVA analysis indicate that the differences in the height of athletes who participated in various track and field disciplines were statistically significant (F=2.97, p=.03), while the subsequent comparisons using LSD test showed that the mean height values significantly differed between the sprinters and jumpers (p=.04), sprinters and throwers (p=.20) and sprinters and decathlon athletes (p=.10); the female athletes also showed a statistically significant difference in height (F=3.54, p=.03) in regard to the groups of disciplines, particularly in sprinters and jumpers (p=.01), while the difference in female throwers was at the limit value (p=.06), but not statistically significant.

A statistically significant difference in weight (F=7.01, p=.00) was observed among the males participants, sprinters and jumpers (p=.02), sprinters and throwers (p=.00) and sprinters and decathlon athletes (p=.00), as well as between middle and long distance runners and throwers (p=.00) and middle and long distance runners and decathlon athletes (p=.01). The body weight also significantly differed among female athletes (F=3.70, p=.03), the throwers being heavier than sprinters (p=.01), jumpers (p=.02) and middle and long distance runners (p=.00) (Table 2).

There was a statistically significant difference in the sum of skinfolds in male athletes (F=4.30, p=.01), the sprinters having significantly lowest value of the sum of skinfolds in relation to the jumpers (p=.04), throwers (p=.00) and decathlon athletes (p=.01), and middle and long distance runners in relation to throwers (p=.03). There was no statistically significant difference in the sum of skinfolds in female athletes (F=0.76, p=.53).

The difference in body density was statistically significant in male athletes (F=4.09, p=.01), sprinters having significantly higher values of body density in relation to the jumpers (p=.05), throwers (p=.00) and decathlon athletes (p=.01), and the throwers in relation to middle and long distance runners (p=.04), while no significant difference was determined in female athletes (F=0.60, p=.62).

The BFP was statistically significantly different among the male participants in regard to the athletic discipline (F=4.02, p=.01); the sprinters had the lowest BFP (M=5.77 %), which was significantly lower compared to the jumpers (p=.04), throwers (p=.00) and decathlon athletes (p=.01), while no significant difference (F=0.60, p=.62) was determined in the female athletes. The body mass index differed in regard to the discipline both in the male (F=3.86, p=.01)
and the female athletes (F=5.40, p=.01). The middle and long distance runners had the lowest average BMI, but it was not statistically significantly different than in sprinters (p=.69) and jumpers (p=.09); however, it was different in throwers (p=.01) and decathlon athletes (p=.03) who had a higher BMI. In male athletes, the BMI was significantly lower in sprinters than in throwers (p=.00) and decathlon athletes (p=.03), while in female athletes: sprinters (p=.01), middle and long-distance runners (p=.00) and jumpers (p=.00) also had a statistically significantly lower BMI than the throwers (Table 2).

### Discussion

The height of world-class sprinters ranges from 168 to 191 cm, and from 152 to 182 cm in females and males, respectively [34]. On average, the national team sprinters of both sexes had average values of body height, whereas they were taller than the American male (177 cm) and female sprinters (168 cm); however, the Serbian male sprinters were shorter than the elite male sprinters (181.6 cm), and on average, the Serbian female sprinters were taller than the elite female sprinters (168.2 cm) [32]. The Serbian national team athletes were shorter than the Croatian top 100 and 200 meter sprinters (182.7 cm) and 400 m (181.3 cm), while the athletes in this study were taller than the Croatian middle-distance runners (180.3 cm) and long-distance runners (181.9 cm) [22]. According to the literature data, the gradual decrease in running distance from marathon to 400-meters, the average body height of runners gradually increases [27, 35]. However, on average, the trend differs in 100 and 200 meter sprinters and they are shorter than 400 m runners (marathon: 171.9±6.17 cm, 3000 m: 175.02±6.55 cm, 400 m: 182.75±6.24 cm, 200 m: 180.99±6.17 cm and 100 m: 179.20±5.94 cm) [27]. Actually, 400 m runners are the tallest male runners [36], while Weyand and Davis confirmed this in both sexes [35]. In our study the sprinters were not divided by individual sprinting disciplines (100 m, 100 m hurdles, 200 m, 400 m and 400 m hurdles) so it was not possible to compare the height of runners in the group of sprinters.

According to Sedeaud et al. the body weight is inversely proportional to the race length, i. e. elite male sprinters have a greater body mass than middle and long distance runners, which is in accordance with Weyand and Davis research findings [35]. Weyand and Davis confirmed this both in male and female runners.

Comparing the results of this study with American sprinters, it can be concluded that the American

### Table 1. The mean and standard deviation of tested variables and significance of differences between the tested variables by track and field disciplines given for male and female participants (One-way ANOVA)

<table>
<thead>
<tr>
<th>Discipline/Disciplina</th>
<th>Height (cm)</th>
<th>Body weight (kg)</th>
<th>Sum (mm)</th>
<th>B. density (g·cm(^{-3}))</th>
<th>BF (masna masa (%))</th>
<th>BMI/Indeks telesne mase (kg/m(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>M ± SD/AS ± SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men/Muškarci/Sprint</td>
<td>180.61 ± 5.89</td>
<td>72.33 ± 6.20</td>
<td>46.74 ± 8.60</td>
<td>1.0861 ± 0.0029</td>
<td>5.77 ± 1.22</td>
<td>22.20 ± 2.04</td>
</tr>
<tr>
<td>Women/Žene/Sprint</td>
<td>168.31 ± 5.36</td>
<td>60.66 ± 6.54</td>
<td>73.76 ± 18.48</td>
<td>1.0627 ± 0.0069</td>
<td>15.82 ± 3.06</td>
<td>21.35 ± 1.35</td>
</tr>
<tr>
<td>Men/Muškarci/Middle and long dist.</td>
<td>182.8 ± 4.17</td>
<td>72.62 ± 4.62</td>
<td>53.62 ± 5.43</td>
<td>1.0833 ± 0.0023</td>
<td>6.94 ± 0.99</td>
<td>21.74 ± 1.46</td>
</tr>
<tr>
<td>Sr. i duge pruge</td>
<td>169.37 ± 5.36</td>
<td>57.62 ± 5.01</td>
<td>61.70 ± 14.92</td>
<td>1.0669 ± 0.0055</td>
<td>13.98 ± 2.39</td>
<td>21.35 ± 1.35</td>
</tr>
<tr>
<td>Women/Žene/Middle and long dist.</td>
<td>186.14 ± 3.50</td>
<td>82.31 ± 8.43</td>
<td>60.89 ± 17.47</td>
<td>1.0809 ± 0.0071</td>
<td>8.06 ± 3.14</td>
<td>23.91 ± 2.63</td>
</tr>
<tr>
<td>Men/Muškarci/Throws/Bacanja</td>
<td>175.23±5.36</td>
<td>62.23±3.82</td>
<td>67.55±10.70</td>
<td>1.0652±0.0042</td>
<td>14.71±1.81</td>
<td>20.27±0.81</td>
</tr>
<tr>
<td>Women/Žene/Throws/Bacanja</td>
<td>187.67 ± 6.73</td>
<td>90.98 ± 12.82</td>
<td>74.28 ± 24.11</td>
<td>1.0759 ± 0.0084</td>
<td>10.10 ± 3.61</td>
<td>25.78 ± 2.60</td>
</tr>
<tr>
<td>Men/Muškarci/Decathlon/Desetoboj</td>
<td>175.75 ± 1.06</td>
<td>73.75 ± 6.01</td>
<td>76.90 ± 6.08</td>
<td>1.0641 ± 0.0014</td>
<td>15.18 ± 0.62</td>
<td>23.90 ± 2.27</td>
</tr>
<tr>
<td>Women/Žene/Decathlon/Desetoboj</td>
<td>188.50 ± 6.25</td>
<td>88.56 ± 11.60</td>
<td>67.74 ± 16.65</td>
<td>1.0786 ± 0.0064</td>
<td>8.94 ± 2.70</td>
<td>24.82 ± 1.88</td>
</tr>
</tbody>
</table>

Legend: M – mean, SD – standard deviation, F – F ratio, p - significance of differences, sum- sum of seven skinfolds (mm), b. density - body density (g·cm\(^{-3}\))

Legenda: AS – aritmetička sredina, SD – standardna devijacija, F – F odnos, p - značajnost razlika, suma‒suma sedam skinfolda (mm), b. density - telesna masa (kg/m\(^2\))
female sprinters (77 kg) have a higher body weight, while American female sprinters (58 kg) have a lower body weight compared to the sprinters of the Serbian national track and field team [34]. Compared to the Croatian sprinters (100 m and 200 m: 76 kg; 400: 72.7 kg) [22], our national team sprinters had a higher body weight. While Colombia’s top long-distance runners were on average 170.6 cm tall and weighed 69.1 kg [19], the middle and long distance runners of our national team were taller and heavier on average. Our female middle and long distance runners, compared with sprinters, were a little taller and lighter which was also the case comparing to top runners (166,2 cm; 58,5 kg) [32]. In this study, the body height and body weight of sprinters and middle and long distance runners were similar, probably because the group of middle and long distance runners of both sexes consisted of mainly 800 m and 1500 m runners, whose body constitution is more like in sprinters.

This trend of body height and body weight of runners has been continuing since the Olympics in Munich (Germany, 1972) and Montreal (Canada, 1976) [36] till today [27, 34, 35].

The body weight and body height of jumpers, throwers and decathlon athletes are consistent with the requirements of their disciplines. In the group of jumpers, men and women were taller and heavier on average compared to the height (M=181 cm; W=166 cm) and weight (M=69.2 kg; W=59.4 kg) of elite athletes [37, 38]. Sadhu et al. found that the throwers were taller and heavier than the athletes in other disciplines [39] which is in accordance with the results of this study. Increased body weight is an advantage in throwing disciplines because more strength is necessary for throwing and it is proportional to the body mass [40]. The Serbian national team throwers were taller and heavier than throwers participating in Abraham’s study in India [41], and shorter and less heavy than men and women in the study of Faber et al. [42] while decathlon athletes were slightly taller and heavier than the participants in the study done by Withers et al. [20].

The sum of skinfolds is an important predictor of results in running and jumping [15]. Legaz et al. found that the Spanish athletes had a lower sum of skinfolds, and concluded that high performance could be attributed to low skinfold levels [21].

The study results are consistent with the research of the Australian athletes, where the male and female sprinters had the lowest sum of skinfolds, i.e. 46.8 mm and 60.3 mm, respectively, and male throwers (javelin) (62.8 mm) and female throwers (95,3 mm) had the highest skinfold levels, proviso that the Serbian female sprinters had a high value of this parameter in relation to the Australian athletes [32]. In relation to the Croatian sprinters, whose average sum of skinfolds in 100 and 200 meter sprinters was 47,7 mm, and in 400 meter runners 47,2 mm [22], our national selection jumpers had a significantly higher sum of skinfolds than their Australian counterparts (which was 37.3 mm in jumpers and 43.2 mm in pole vaulters) [32].

Table 2. Significance of differences between the tested variables by track and field disciplines given for male and female participants (One-way ANOVA)

<table>
<thead>
<tr>
<th>Discipline/Disciplina</th>
<th>Height (cm)</th>
<th>Body weight (kg)</th>
<th>Sum (mm)</th>
<th>B. density (g·cm²)</th>
<th>B. fat (%)</th>
<th>B. mass index (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men/Muškarci</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sprint/Jumps/Sprint/Skokovi</td>
<td>0.04</td>
<td>0.02</td>
<td>0.04</td>
<td>0.05</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>Sprint/Throws/Sprint/Bacanja</td>
<td>0.20</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
</tr>
<tr>
<td>Sprint/Decathlon/Sprint/Desetoboj</td>
<td>0.10</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Middle and long dist./Throws</td>
<td>0.01</td>
<td>0.00</td>
<td>0.03</td>
<td>0.04</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Middle and long dist./Decathlon</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Women/Zene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sprint/Jumps/Sprint/Skokovi</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Throws/Sprint/Bacanja/Sprint</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Legend: p - significance of differences, sum - sum of seven skinfolds (mm), b. density - body density (g·cm²), b. fat - body fat (%), b. mass index – body mass index (kg/m²). Note: no statistically significant difference was found between the track and field disciplines in empty fields.

The results indicate that throwers have significantly higher skinfold levels than the track and field athletes, that is in accordance with Asian top throwers [41]. The sum of skinfolds can also predict the sprint performance and the best personal records in the female throwers.

The Australian athletes, who have lower average sums of skinfolds, are much faster and have better medal score in major international competitions [45] in races at the 100, 200 and 400 meters, compared with their Serbian counterparts.

In various studies the sum of skinfolds does not always include the same individual skinfold points or their number [6–8, 10, 16, 17, 19–24], varying from three to ten [30, 31], and also does not include approximately the same number of respondents, so it is impossible to conduct a valid detailed analysis between athletes of different national track and field teams.

Body mass index is used as the most optimal indicator of the nutritional status level and diagnosis of obesity [44]. BMI decreases as the length of running distance increases, and as the performance increases the index decreases; however, it always lies in the proper optimum [27]. In the period from 1996 to 2011, the BMI and weight of the world’s best sprinters (races from 100 to 400 m) were higher than in the middle and long distance runners (from 800 m to marathon). In addition, there was a significant positive correlation between the BFP and the BMI of male athletes in the study of Sedeaud et al. (sprint 22 to 24 kg/m², middle and long distance 20 - 21 kg/m²) [27] and American male sprinters (M=23.7 kg/m²) and female sprinters (20.4 kg/m²) [34]. The highest BMI was observed among the throwers of both sexes.

The study results suggest that the BMI in our sprinters and the middle and long distance runners is in the range of the world-class athletes included in the study of Sedeaud et al. (sprint 22 to 24 kg/m², middle and long distance 20 - 21 kg/m²) [27] and American male sprinters (M=23.7 kg/m²) and female sprinters (20.4 kg/m²) [34]. The highest BMI was observed among the throwers of both sexes.

The BMI results of throwers are in agreement with the results of throwers who have no top results (25.7 kg/m²) compared to the top throwers (28.4 kg/m²) [46]. All male athletes in the study were taller, heavier and had a higher BMI compared to female athletes.

The previous studies have shown that runners of all disciplines have a lower BFP compared to other disciplines [24, 32] while throwers have the highest BFP in relation to other track and field athletes [41], which is in accordance with the study results for male participants.

This study also showed that the female sprinters had a slightly higher BFP compared to the throwers. This can be explained by a small sample size in the group of female throwers, one of them being a javelin thrower, and the demands for this discipline are different from those for other throwing disciplines, with a different body composition, which is a limitation of the study. Furthermore, most of the national team athletes are not professionals but amateurs, whose intensity and volume of training processes are much lower compared to the professionals. Increasing demands of professional sports require different anthropometric characteristics and different body composition of these athletes compared to the amateurs. In most sports [46–49] including track and field disciplines, a statistically significant difference between elite (professional) and amateur athletes is determined in terms of anthropometric characteristics and body composition. Since a decreased sum of skinfolds can be attributed to high performance [21], this may be the reason why the sum of skinfolds is higher in athletes of the national selection than in top athletes.

The fact that the female participants in this study did not have top results in their disciplines may be the reason for the absence of statistically significant difference in the sums of skinfolds, body density, and BFP among athletes of various disciplines. The sum of skinfolds was measured in order to calculate the body density and the BFP; therefore, future studies should analyze individual skinfolds and differences in relation to other national teams.

In addition, a limitation of this study was a small sample of participants of different sex in certain disciplines and therefore the inability to divide the participants inside the groups and analyze them. Except for the above mentioned, different studies included different distributions of participants into groups, for example, in some studies sprinters were divided into subgroups of runners in the 100 m, 200 m and 400 m races, while in other studies hurdles (which belong to sprint events) were analyzed as jumps. Moreover, the literature results have been obtained by using a very wide range of participants who have been measured in different continuum of time. Apart from that, the literature gives a different number of skinfolds analyzed at different anatomical regions. For these reasons it was very difficult to make a detailed comparison of the body composition between athletes of the national selection and other national track and field teams.

Conclusion

Measurements of total and regional body composition may be useful to improve athletic results as well as to prevent injury and assess health risks. Considering the fact that our male and female athletes showed higher sums of skinfolds, compared to other elite athletes who belong to more successful national track and field teams, adequate education of coaches and athletes, as well as more accurate body composition assessment methods may increase the loss of body fat and indirectly improve the results.
References


