Body composition in students physical education and sport: cross-sectional pilot study

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Abstract

Purpose: Young people who study physical education and sport are a priori regarded as having proper body structure and body composition. It is widely presumed that young who study physical education at one of several national universities of physical education (East Sarajevo) could be characterized with proper physique and body composition. Aim of the current study was to assess and analyze the body composition of a male students Physical Education and Sport, University East Sarajevo, by bioelectric impedance analysis and determine the significance of inter correlation coefficients.

Material and methods: In study the participants consist 30 male students of Faculty of Physical Education and Sport, University of East Sarajevo, the III year of study (Body Height = 182.20 ± 6.89cm; Body Weight = 80.06 ± 8.80kg; Body Mass Index= 24.03 ± 2.58kg/m²).

Results: of the study showed that the body composition is within the healthy (allowed) values recommended for this population of students (Body Fat=10.90kg or 13.62%; Body Muscle= 65.74kg or 82.40%; Body Water = 61.54%; Basal metabolic rate = 2045.07kCal; Daily calorie intake = 8436.56 kCal, etc.). Inter correlation coefficients showed inverse and significantly high correlation (p=0.000) between (inter correlation coefficient Fat-Muscle = -0.945), (inter correlation coefficients Fat-Water = -0.963) while direct correlation was achieved between (inter correlation coefficient Muscle-Water = 0.986).

Conclusion: The obtained results of the study defined the appropriate body composition of the students, which is a consequence of their adequate physical activity and well-designed curricula at the home faculty. In the parameters of body composition, students of physical education and sports in East Sarajevo had a higher muscle component and lower values of fat component than other students as a result of their somatotype, way of studying, teaching and extracurricular physical activities.

Key words: students of Physical Education and Sport, body composition, bioelectric impedance analysis, correlation analysis
Анотація

Ратко Павлович. Композиція тіла студентів факультетів фізичного виховання і спорту: перехресне пілотне дослідження

Мета: Молоді люди, які займаються фізкультурою та спортом, априорі вважаються такими, що мають належну будову тіла та будову тіла. Широко припускається, що молодь, яка вивчає фізичне виховання в одному з кількох національних університетів фізичного виховання (Східне Сараєво), може мати належну статуру та композицію тіла. Метою поточного дослідження було оцінити та проаналізувати склад тіла студентів-чоловіків, студентів фізичного виховання та спорту, Університет Східного Сараєво, за біоелектричним імпедансним аналізом та визначити значення коефіцієнтів взаємозв'язку.

Матеріал і методи: У дослідженні брали участь 30 студентів-чоловіків факультету фізичного виховання та спорту Університету Східного Сараєво, III рік навчання (звіст тіла = 182,20 ± 6,89 см; маса тіла = 80,06 ± 8,80 кг; індекс маси тіла = 24,03 ± 2,58 кг/м²).

Результати: дослідження показало, що склад тіла знаходиться в межах здорових (дозволених) значень, рекомендованих для цієї групи студентів (Жир = 10,90 кг або 13,62%; М'язи тіла = 65,74 кг або 82,40%; Вода в організмі = 61,54%; базальна швидкість метаболізму = 2045,07 ккал; добове споживання калорій = 8436,56 ккал тощо). Коефіцієнт взаємозв'язку показав обернену та значно високу кореляцію (р=0,000) між (коєфіцієнт взаємозв'язку Жир-М'язи=-0,945), (коєфіцієнт взаємозв'язку Жир-Вода=-0,963), тоді як пряма кореляція була досягнута між (коєфіцієнт взаємозв'язку М'язи-Вода= 0.986).

Висновок: Отримані результати дослідження визначили відповідний склад тіла студентів, що є наслідком їх достатньої фізичної активності та грамотно розроблених навчальних програм на рідному факультеті. За параметрами будови тіла студенти фізкультури та спорту Східного Сараєво мали вищий м'язовий компонент і нижчі значення жирового компонента, ніж інші студенти, що вплинуло на їх соматотип, способі навчання, викладання та позакласної фізичної діяльності.

Ключові слова: студенти з фізичної культури і спорту, композиція тіла, біоелектричний імпедансний аналіз, кореляційний аналіз

Аннотация

Ратко Павлович. Композиция тела студентов факультетов физической культуры и спорта: профильное пилотное исследование

Цель: Молодежь, изучающая физическую культуру и спорт, априори расценивается как имеющая правильное телосложение и состав тела. Широко распространено мнение, что молодые люди, изучающие физическое воспитание в одном из нескольких национальных университетов физического воспитания (Восточное Сараево), могут характеризоваться правильным телосложением и составом тела. Цель настоящего исследования состояла в том, чтобы оценить и проанализировать состав тела студентов мужского пола по физическому воспитанию и спорту Университета Восточного Сараево с помощью биоимпедансного анализа и определить значение коэффициентов взаимосвязей.

Материал и методы: В исследовании приняли участие 30 студентов мужского пола факультета физического воспитания и спорта Университета Восточного Сараево, III курс обучения (рост = 182,20 ± 6,89 см; масса тела = 80,06 ± 8,80 кг; индекс массы тела = 24,03). ± 2,58 кг/м²).

Результаты: исследование показало, что состав тела находится в пределах здоровых (допустимых) значений, рекомендованных для данной популяции студентов (Жир = 10,90 кг или 13,62%; Мышцы тела = 65,74 кг или 82,40%; Вода в организме = 61,54%; базальная скорость метаболизма = 2045,07 ккал; суточное количество калорий = 8436,56 ккал и т. д.). ICC показал обратную и значительно высокую корреляцию (р = 0,000) между (коэффициент взаимосвязи жир-мышцы = -0,945), (коэффициент взаимосвязи жир-вода = -0,963), в то время как прямая корреляция была достигнута между (коэффициент взаимосвязи мышца-вода = 0,986).

Заключение: Полученные результаты исследования определили соответствующий состав тела студентов, что является следствием их адекватной двигательной активности и правильно составленных учебных программ на домашнем факультете. По параметрам телосложения у студентов физкультуры и спорта Восточного Сараево более высокие значения мышечного компонента и более низкие значения жирового компонента, чем у других студентов, что обусловлено их соматотипом, способом обучения, преподавания и внеучебной физической активностью.

Ключевые слова: студенты физической культуры и спорта, композиция тела, биоимпедансный анализ, корреляционный анализ
Introduction

Lack of movement (hypokinesia) reflects the time in which modern man lives and movement is one of the important factors in maintaining good health. In today’s era of modern lifestyle, there is less and less physical activity (PA). As a consequence of "hypokinesia", many negative consequences for human health occur. Numerous deformities of the locomotor system occur at a younger age, while various metabolic and cardiovascular diseases are present in the older population [1-5]. Low levels of PA most often lead individuals to an increased risk of obesity and cardiovascular disease [6]. On the other hand, physical activity has been suggested as a means of reducing and controlling body fat. PA has important health benefits for adolescents and adults, and is associated with more favorable biological cardiovascular diseases (lower blood pressure, more favorable serum lipids and lipoproteins, and reduced adiposity) than less active or fit individuals, improving their ability to perform everyday tasks [7] More generally, regular PA has been shown to effectively reduce various health risk factors, especially those related to cardiovascular disease and metabolic syndrome [8, 9]. Part of the effects of PA are thought to be through lowering blood pressure, improving lipid metabolism, and reducing body weight [10, 11]. Previous studies [12-17] confirmed that PA or aerobic exercise is inversely related to blood pressure. The American College of Sports Medicine recommends that adults engage in at least 150 min- wk−1 of moderate intensity cardiovascular exercise and at least 75 min wk−1 of vigorous intensity training, in order to maintain a sufficient level of cardio-respiratory fitness. Resistance training is also suggested 2–3 day wk−1 [18].

Certain effects of increased physical activity include certain changes in the body composition of each organism [19-21]. Also, the level and magnitude of the observed changes depend on the type of physical activity or sport that the individual engages in as well as on his individual characteristics, abilities and predispositions. This usually includes gender, age, somatotype and specific dynamics of one’s metabolic process in the body, which is a prerequisite for the formation of an appropriate body composition [22]. Several methods are used to analyze and measure body composition, and the most accurate measurement methods are magnetic resonance imaging and computed tomography [23]. Unfortunately, these methods are expensive and are mainly used in medical diagnostics because their wide application in population studies is difficult to justify. However, the use of bioelectrical impedance analysis (BIA) is a relatively simple and non-invasive method for indirectly estimating overall body composition. BIA analysis is used in studies to assess body composition (e.g. total extracellular, intracellular water compartments, muscle mass, adipose tissue, body mass, resistance, basal metabolism). Its use is becoming increasingly popular because it is safe, fast, easy to use and suitable for laboratory, clinical and field assessments of the composition of the human body [24]. Due to its confirmed high repeatability, BIA is widely used in population studies as well as in replicating research [25] to enable comparative analysis of study results in different populations. The obtained information on body structure is multifunctional and can be used in different cases and with different population groups, including the student population.

With the transition to university, there are changes in the lifestyle of individuals, in terms of greater independence and increased social relations with peers, with many colleges becoming a sensitive population group in terms of diet and lifestyle [26]. Thus established new social relations and way of life most often shorten the time towards physical activity, reduce the quality of nutrition, which results in deterioration of physical composition and physical fitness of students during the school year [27, 28] show the findings of studies in several countries where poor activity, poor diet and smoking are serious health problems among students [29]. Students of physical education and sports (PES) represent a special population of healthy young people for whom PA is primary, which is in line with the specifics of their study plans and programs. Their PA is manifested through various forms of sports, most of which are included in the program of the Summer and Winter Olympic Games. In this regard, it is considered and expected that students of these faculties will have a different body composition compared to the population of the same chronological age, bearing in mind the continuity of their physical activities during their studies, also through various extracurricular activities (engagement in sports clubs and other types of recreation). A study by Grima, & Blay [30] conducted in Spain showed that students of physical education and sports have a healthier lifestyle, better cardiovascular profile and less body fat than students of other faculties, which may be due to the curriculum, which promotes active and a healthy lifestyle, in addition to having practical classes in which students participate in PA. In this regard, some research on the population of students of physical education and sports [22, 31 - 36] analyze issues of body composition, impact on motor manifestations, fitness index, correlation with
physical activity of students, differences between students of different geographical regions, correlations between body composition with physical fitness, nutritional habits, fitness and anthropometric parameters, which leads to the conclusion that physical status is a variable category and is primarily dependent on adequate PA of the individual and their lifestyle.

When enrolling at the faculty of physical education and sports, it is understood that future students have an adequate level of motor and functional potentials as well as an appropriate body composition that will, in the best possible way, enable them to realize planned PA during their studies. Almagià Flores, Lizana Arce, Rodriuez Rodriuez, et al. [31] suggest that the body composition of the student is of vital importance because it will be an excellent profit in subjects that require physical effort. It is widely believed that young people studying at the faculty of physical education and sports at one of the two national universities of Republic of Srpska (East Sarajevo) could be characterized by proper morphological structure, appropriate motor-functional potential and appropriate body composition. However, this assumption cannot be confirmed because so far there has been no research regarding the detection and analysis of physical status with students of this faculty. Due to this fact, it was considered useful to analyze and learn more about the physical development of these young people (students) who chose to study to become physical education teachers, sports coaches, instructors of recreational and sports activities or organizers of sports and recreation.

The aim of this pilot study is the detection and analysis of body composition of male students at the Faculty of Physical Education and Sports, University of East Sarajevo, using BIA. The study made it possible to identify the components of body composition that define and distinguish this physically active population (the so-called healthy population) from the physically less active population. There will also be information on the possibilities of students for the realization of practical classes at the faculty, especially in the field of aerobic and anaerobic activities.

Material and methods

Participants of study

This was a cross-sectional pilot study carried out on a total of sample 30 male students, Faculty of Physical Education and Sport, East Sarajevo (III year of study) (Body height=182.40±6.89cm; Body weight=80.06±8.80kg; BMI=24.03±2.58kg/m². A total of 19 variables were measured to assess BC:

1. Body fat (kg),
2. Body fat (%),
3. Body muscle (kg),
4. Body muscle (%)
5. Body water (%),
6. Right arm muscle (kg)
7. Left arm muscle (kg)
8. Trunk muscle (kg)
9. Right leg muscle (kg)
10. Left leg muscle (kg)
11. Right arm fat (%)
12. Left arm fat (%)
13. Trunk fat (%)
14. Right leg fat (%)
15. Left leg fat (%)
16. Visceral fat
17. Bones (kg)
18. Basal metabolic rate - BMR (kCal)
19. Daily calorie intake-DCI (kcal)

Experimental design

This study followed a cross-sectional design. The standard metric instruments were applied according to the methodology of the International Society for the Advancement of Kinanthropometry (ISAK). Body weight and Body composition (BC) were assessed with the Bioelectrical Impedance Analysis (BIA) using a body composition analyser (Tanita Inner ScanV BC-545N, Tokyo, JAPAN), in accordance with the measurement protocol. The participants were informed in about the nature of the study and investigational procedures, and all the participants have voluntarily given their consent to be the part of this study. The measurements were according to the procedures in the Helsinki declaration.

Bioelectrical Impedance Analysis (BIA)

Body composition monitor was used to assess the variables of body composition of the participants. It is a device that measures the body weight, body fat percent, visceral fat, skeletal muscle mass, and resting metabolic rate which works according to Bioelectrical Impedance Analysis (BIA) which analyzes the electrical resistance of the body tissues by sending extremely weak electrical current through the body. The following procedures were used for the measurement [37]
1. The power switch was press to turn on the machine.
2. Each participant mounted the machine bare footed.
3. Raise your arms horizontally and extend your elbows straight to form a 90° angle to your Body.
4. Stand with your knees and back straight and look straight ahead.
5. Hold the display unit in front of you.
6. Step on the Main Unit barefoot.
7. Make sure the heels are positioned on the heel electrodes.
8. Stand with your weight evenly distributed on the measurement platform.

**Data analysis**

The descriptive statistic were calculated. The statistical package Statistica, version 10.0 (STA999k347150-W) was used for data processing.

**Results**

The obtained results define the physical status of students of PES. More than 95% of student respondents engage in extracurricular physical activities (sports clubs, gym, fitness clubs). The presents the statistical parameters of the BC of the analyzed sample of male students (Table 1. Figure 1). The results confirmed that body fat determines 13.62 ± 5.60% (5.20-26.10%) of body composition, which is mean 10.90±4.92kg of fat mass (3.90-20.30kg). Of the total body mass of the sample (80.06kg), muscle mass is contained in 82.40±4.80% (or 73.78-90.10%), which is mean 65.74±5.79kg (56.60-81.50kg), while bones as part of the skeleton and total body mass take part with 3.42 kg (3.00-4.20kg) which is an indicator of the appropriate mineral status of the bones of the organism.

**Table 1**

<table>
<thead>
<tr>
<th>Body composition</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>SD (CI SD ±95%)</th>
<th>Coef.Var.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body fat (kg)</td>
<td>10.90</td>
<td>3.90</td>
<td>20.30</td>
<td>4.92 (3.92-6.62)</td>
<td>45.18</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>13.62</td>
<td>5.20</td>
<td>26.10</td>
<td>5.60 (4.61-7.79)</td>
<td>41.15</td>
</tr>
<tr>
<td>Body muscle (kg)</td>
<td>65.74</td>
<td>56.60</td>
<td>81.50</td>
<td>5.79 (4.80-6.45)</td>
<td>8.81</td>
</tr>
<tr>
<td>Body muscle (%)</td>
<td>82.40</td>
<td>73.78</td>
<td>90.10</td>
<td>4.80 (3.82-6.45)</td>
<td>5.83</td>
</tr>
<tr>
<td>Body water (%)</td>
<td>61.54</td>
<td>53.90</td>
<td>68.40</td>
<td>4.23 (3.37-5.68)</td>
<td>6.87</td>
</tr>
<tr>
<td>Right arm muscle (kg)</td>
<td>4.01</td>
<td>3.40</td>
<td>5.40</td>
<td>0.45 (0.36-0.60)</td>
<td>11.20</td>
</tr>
<tr>
<td>Left arm muscle (kg)</td>
<td>4.00</td>
<td>3.30</td>
<td>5.60</td>
<td>0.49 (0.39-0.66)</td>
<td>12.26</td>
</tr>
<tr>
<td>Trunk muscle (kg)</td>
<td>35.53</td>
<td>29.60</td>
<td>44.40</td>
<td>3.45 (2.75-4.64)</td>
<td>9.71</td>
</tr>
<tr>
<td>Right leg muscle (kg)</td>
<td>11.28</td>
<td>9.90</td>
<td>13.10</td>
<td>0.78 (0.62-1.05)</td>
<td>6.90</td>
</tr>
<tr>
<td>Left leg muscle (kg)</td>
<td>10.91</td>
<td>9.70</td>
<td>13.00</td>
<td>0.79 (0.63-1.07)</td>
<td>7.27</td>
</tr>
<tr>
<td>Right arm fat (%)</td>
<td>12.65</td>
<td>6.20</td>
<td>18.90</td>
<td>3.02 (2.40-4.05)</td>
<td>23.85</td>
</tr>
<tr>
<td>Left arm fat (%)</td>
<td>13.51</td>
<td>6.80</td>
<td>20.60</td>
<td>3.65 (2.90-4.90)</td>
<td>26.99</td>
</tr>
<tr>
<td>Trunk fat (%)</td>
<td>13.56</td>
<td>5.00</td>
<td>25.00</td>
<td>6.53 (5.20-8.78)</td>
<td>48.18</td>
</tr>
<tr>
<td>Right leg fat (%)</td>
<td>12.64</td>
<td>4.20</td>
<td>21.70</td>
<td>4.08 (3.25-5.48)</td>
<td>32.25</td>
</tr>
<tr>
<td>Left leg fat (%)</td>
<td>13.38</td>
<td>5.90</td>
<td>20.60</td>
<td>3.70 (3.00-4.20)</td>
<td>27.63</td>
</tr>
</tbody>
</table>
It is evident that numerical analysis of segmental muscle status defines significant symmetry between the left and right sides of the cranial and caudal extremities. The right arm 4.01kg (min-max 3.40-5.40kg) contains identical mean muscle mass than the left arm 4.00kg (3.30-5.60kg). Right leg 11.28kg (9.90-13.10kg) contains slightly more in relation to the left leg 10.91kg (9.70-13.00kg). The largest muscle mass is present in the trunk muscle 35.53kg (29.60-44.40kg). Regarding the average representation of adipose tissue for trunk (13.56%), differences between the cranial and caudal extremities is evident (Table 1, Figure 1). They generally maintain an inverse relationship with muscle tissue and water values (water, 61.54%) as expected. The right arm contains an average of 12.65% adipose tissue (6.20-18.90%) and is slightly less than the fat percentage of the left arm 13.51% (6.80-20.60%). The proportion of adipose tissue in the caudal extremities recorded identical average values (right leg, 12.64% vs. left leg 13.38%) as well as ranges of min. and max. results. Carcass fat content contains close to 13.56% (5.00-25.00%), which is within healthy limits, without the possibility of amenorrhea with loss of minerals in the bone. Body composition reflects a slight heterogeneity within the sample for body fat (kg), which may be due to poorer selection when selecting, biological differences, training process, extracurricular physical activities, acceleration growth, physical fitness, etc.

Out of a total of six inter correlation coefficients (ICC) between anthropometric parameters (height, weight) with the amount of fat, muscle component and water content in the body, four showed a high statistical correlation (Figures 2,3,4,5). Body height records a positive correlation only with muscle mass (r = 0.550; p=0.000), while there are insignificant correlations with the amount of fat and water in the body. It turns out that students with higher body weight also had a larger muscle component. In contrast to height, body mass is in a significant linear relationship with the amount of fat in the body (r = 0.748; p = 0.000) and muscle component (r = 0.843; p = 0.000) while inversely related to the amount of water in the body = -0.605; p = 0.000). ICC body composition, ie muscle mass and water content showed a very high and statistically significant direct ratio (r = 0.986; p = 0.000), in contrast to ICC body

![Fig. 1. Body composition of students Physical Education and Sport](image-url)
fat and muscle component content ($r = -0.945; p = 0.000$), that is, fat and water content ($r = -0.963; p = 0.000$) that maintained a strong inverse relationship (Figures 6, 7, 8). This points to the fact that students who had a pronounced muscle component have more water and less fat in the body. Similar results also refer to the inverse correlation of the fat component with the amount of water in the body ($r = -0.944; p = 0.000$).

![Fig. 2. Correlation Body height (cm) vs. Body muscle (kg)](image)

![Fig. 3. Correlation Body weight (kg) vs. Body water (%)](image)
Fig. 4. Correlation Body weight (kg) vs. Body muscle (kg)

Fig. 5. Correlation Body weight (kg) vs. Body fat (kg)

Fig. 6. Correlation Body fat (%) vs. Body muscle (%)
Discussion

The aim of the study was to detect and analyze the body composition of a group of 30 male students of Faculty PES at the University of East Sarajevo. The analysis assessed 19 body composition parameters and determined ICC. The obtained results confirm the positive numerical values of all parameters of body composition. From the health aspect, i.e. possible negative consequences for the health of our sample, these are good results. The values of body fat (13, 62%) and visceral fat (2.25) are healthy norms so that their values were not detected as risk factors for some diseases and a negative factor in PA.

According to Vehrs & Hager [38] most body fat is deposited in fat cells (adipocytes) under the skin (subcutaneous fat) and around organs (visceral fat). Some fat (3-5% in men; 8-12% in women) is necessary for normal bodily functions, such as fat that is part of the nervous system or surrounding visceral organs in women [39]. Body fat has three important functions in the human body (serves as an insulator to preserve body heat, is a source of fuel for metabolic energy and as a basis for protection) but excess increases the risk of cardiovascular disease, type 2 diabetes, hypertension, hyperlipidemia, metabolic syndrome, coronary artery disease, intermittent claudication, stroke [40].

In the current study, significantly high ICC of anthropometric and body composition parameters
of students are evident. Body height is directly related only to muscle mass, while body weight is directly related to the amount of fat and muscle in the body, and inversely related to the amount of water in the body. And the measured impedance is related to the size and shape of the body and the amount of water in the body. Since a large part of skeletal muscle is only water, the measured impedance is used to estimate the total water content in the body (%), which in turn can be used to estimate FFM. Factors affecting the water content in FFM will affect the accuracy of predicting body fat percentage (%BF). The higher presence of fat in the body prevents the presence of water, especially in muscles [38]. These changes are due to the positive effects of student physical activity during studies and the faculty curriculum which supports the findings of some earlier studies [19, 21, 22].

The muscular component of our sample is dominant with more than 82% participation (66kg) which is a good result and an indicator of a significant presence of student physical activity. Increased calorie intake can be explained by the fact that in this population a better metabolic product is necessary, i.e. higher caloric consumption as a result of consumption in physical activity, which is in line with a study [41] that defines a negative correlation between physical activity, energy expenditure, and fat percentage in men. Men are more likely to engage in team sports (football, basketball, volleyball, handball) or in strength-related activities, e.g. body building, fitness, martial arts, athletics involving intense repetitive efforts, which are positively correlated with fat loss [42]. It turns out that different adaptations of the organism can be related to the type of sport. Considering that they are students of physical education and sports, these results are therefore expected. The results of our sample of students in terms of height, body weight and BMI are higher average values than the Italian sample of sports science students [33] for values of height (182.40cm vs. 177.60cm), body weight (80.06kg vs. 75.60 kg), while the parameters of body composition are lower (Body Fat 13.62% or 0.90kg vs. 17.3% or 13.3kg) and muscle components (65.74kg vs. 62.4kg). There are also significantly higher anthropometric measures compared to Japanese students [43] while body composition is slightly lower in Japanese students (Body Fat 12.3% or 7.9kg, Body Muscle 55.4kg).

Authors López-Sánchez, Radziminski, Skalska, et al. [36] analyze differences in body composition, physical activity, and diet between Polish and Spanish male sports science students. The results show that Polish students have better values of physical composition and physical activity, while Spanish students are defined by a healthier lifestyle. To avoid future risks of diseases such as obesity or diabetes, Polish physical education and sports curricula should include more lessons that promote an active and healthy lifestyle, while Spanish curricula require more physical activity and sport. Faculties of sports sciences should include more active practical classes in which students could improve their physical status and physical fitness through physical exercise. Compared to Polish sports students from Gdańsk (180cm-78.80kg) our sample defines higher values of anthropometric parameters, body height and body weight, but also lower numerical values of the fat component which is more pronounced in Polish students (Body Fat 14.28%-11.69kg). The percentage of water content is almost identical with a slight increase in the field sample (62.67% vs. 61.54%). The muscle component recorded a higher value of Polish students (67.11 kg-85.71%) compared to our sample (65.74 kg-82.40%) but also an average lower BMR (1995.03 vs. 2045.07). Our sample of students compared to Spanish sports students from Murcia is primarily defined by bigger height (182.40cm vs. 178cm) and body weight (80.06kg vs. 75.31kg). They also have less isolated adipose tissue in the body compared to the Spanish (Body fat 13.62%-10.90kg vs. 14.73%-11.41kg). The water content in the body is slightly higher in the Spanish sample (62.82%) compared to students in East Sarajevo (61.54%). When it comes to the muscle component, it is more dominant in the sample of our students compared to the Spanish (65.74kg -82.40% vs. 63.92kg 85.26%) who also recorded a lower BMR (1895.60).

The lower fat content by 2 kg (2%) in physically active students compared to less active students is confirmed by the research of [22]. Adipose tissue participates from 15-17% while the muscle component occupies 44 kg of total body weight with 45% water. The results confirm that the level of physical activity is not related to body height, body weight and absolute amounts of other studied components of body composition. Compared to the previous research, our sample defines a lower fat content (by about 3%), a more dominant muscle component by almost 20kg and more water by 21%. The results of this study do not support the results of previous research, but are consistent with the results of [30] supporting the thesis on the impact of physical activity through the practical teaching of sports faculties on lower fats in the body of individuals. The results of the current study are in line with the conclusions of the research [31] which imply the negative impact of adipose tissue on the manifestations of motor skills from space speed, strength and aerobic endurance.
It can be assumed that the physical adaptation of students in East Sarajevo is a positive response to the programmed physical activity that is associated with increasing muscle mass, reducing body fat and vice versa. Physical adaptation in response to a large amount of weekly physical activity through practical lectures and exercises can be correlated with a reduced percentage of fat and an increase in muscle mass and at the same time with the general health of the student sample.

Conclusions

The obtained results of the study defined the appropriate body composition of students of PES (Fat-13.62%; Muscle-82.49%; Water-61.54%; Visceral Fat-2.25; BMR = 2045.07kCal; DCI = 8436.56 kCal …), which is a consequence of their adequate PA and well-designed curricula at the home faculty. Good body composition of individuals is a prerequisite for good realization of both motor and functional abilities. The ICC results confirmed a highly inverse and statistically significant relationship between the amounts of fat in the body on the one hand and muscle mass and water content on the other. Students who had more muscle mass and more water also had less fat in their bodies. Compared to students from other countries, our sample of students in terms of anthropometric parameters (height, mass) is superior. In terms of body composition, students of PES in East Sarajevo had a higher muscle component and lower values of fat component, than students from other countries, which is a consequence of their somatotype, way of studying, curricular and extracurricular physical activities. The physical status defined in this way will enable more adequate performance of certain aerobic and anaerobic activities of students. As a recommendation for future research would go in the direction of involving significantly more students, e.g. all four years of study.

Conflict of interest

The authors declare that there is no conflict of interest.

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