

PROFILE OF THE PHYSICAL STATUS OF STUDENTS AT THE ACADEMY FOR NATIONAL SECURITY: INITIAL MODELING

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SUMMARY

This study aimed to investigate the morphological characteristics of male and female students at the Academy for National Security. The sample consisted of 54 healthy first and second-year students, including 41 males (age: 19.83 ± 0.74 yrs.; body height: 181.01 ± 7.26 cm; body mass: 76.77 ± 8.90 kg) and 12 females (age: 19.62 ± 0.65 yrs., body height: 169.72 ± 4.20 cm; body mass: 68.65 ± 8.91 kg). All measurements were performed during the academic year 2023-2024 at the Methodological Research Laboratory (MIL) at the Faculty of Physical Education and Sport, University of Belgrade. The measurement of body composition was carried out using multisegmental bioelectrical impedance, using the device: "InBody 720". Six body composition variables were analyzed: Body Mass Index (BMI), Percent of Body Fat Mass (PBF), Percent of Skeletal Muscle Mass (PSMM), Skeletal Muscle Mass Index (SMMI), Fat Mass index (FMI) and Protein Fat Index (PFI). The values obtained for all variables were processed using basic descriptive statistics. The results showed that the mean BMI of male and female students was 23.41 ± 2.21 kg·m⁻² and 23.82 ± 2.89 kg·m⁻², PBF was 13.32 ± 4.06 % and 29.94 ± 5.02 %, PSMM was 49.38 ± 2.91 % and 38.72 ± 2.98 %, SMMI was 11.53 ± 1.00 kg·m⁻² and 9.17 ± 0.84 kg·m⁻², FMI was 3.15 kg·m⁻² and 7.24 kg·m⁻², PFI was 1.51 ± 0.73 and 0.48 ± 0.12 . Based on the results, it can be concluded that the current morphological status of students at the Academy for National Security falls within the category of the population with average anthropometric and morphological status of students at the University of Belgrade, with females having a higher percentage of body fat, exceeding the biological maximum for females.

Key words: bioelectrical impedance, percent of body fat mass, University of Belgrade, morphological status.

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INTRODUCTION

Body composition assessment is used to monitor progress and training in the sports community and to determine the health status of the population as a whole (Zaccagni, 2014). Body composition assessment provides information on the nutritional status and functional capacity of the human body. It is valuable in nutritional science for describing growth and development from birth to adulthood, as well as for understanding the developmental basis of health and disease, designing nutritional strategies and monitoring therapeutic interventions. Independent of body fat, which is an indicator of long-term energy storage, skeletal muscle is of great importance, and to understand the metabolic balance between muscle and fat compartments, measurement of body composition is necessary (Kuriyan, 2018). The human body consists of four basic segments that represent the most important biologically measurable substances: water, fat, proteins and mineral components. Based on these elements, indices are determined that represent individual elements in the body that determine body structure (Dopsaj et al., 2013).

The level of physical activity influences physical condition, health and quality of life. It is important to engage in physical activity at varying intensities up to the age of 25–30 years to maximize the development of motor skills and physical fitness (Blair et al., 2001; Chakravarthy et al., 2002). Many studies have highlighted the risks associated with excessive energy intake and sedentary lifestyles in young adults and their association with the development of cardiovascular disease and obesity (Gill et al., 2006; Powell-Wiley et al., 2021). With this in mind, we will use bioelectrical impedance (InBody, 720) in our study to examine body composition and present the profile of the student's physical condition. Bioelectrical impedance analysis (BIA) has recently gained wide recognition as a method for estimating body composition as it presents itself as a relatively simple, quick and non-invasive option (Malavolti, 2003).

In addition to social and personal changes, biological changes are also common during the study period. Intense stress, changes in the environment, lack of free time and other factors contribute to reduced physical activity and increased food intake. This combination often leads to a significant increase in obesity or the accumulation of body fat. Assessment of students' body composition is a critical factor in detecting obesity, which can be associated with medical problems such as hypertension, diabetes, and heart disease (Jackson & Pollock, 1985). Therefore, measuring students' body composition should be an essential process during their studies.

The scientific study of the morphological state, body composition and functional characteristics of the student population is a common area of research. The study by Beaudry et al., (2019) examined the changes in body weight and body composition during the first year. The results showed that male and female students experience unfavorable changes in diet and body composition during their first year at university. In addition, the aim of the study by Deng et al. (2023) was to investigate the changes in physical activity and body composition in first semester university students. After the measurements, it was found that the students had gained 4 kg during this period, although their eating habits were relatively healthy. There are also other studies

that have examined the morphological and functional characteristics of university students (Pavlović et al., 2015; Zaccagni, 2014; Dopsaj et al., 2019; Dopsaj et al., 2018; Dopsaj et al., 2020; Rovačin et al., 2023), but there is a lack of data on the body composition of students at the Academy of National Security. This study aims to investigate the morphological characteristics of male and female students at the Academy for National Security.

MATERIALS AND METHODS

Study participants

The study was conducted on 54 healthy students in their first and second year at the Academy for National Security, of which 41 were male (age: 19.83 ± 0.74 yrs.) and 12 were female (age: 19.62 ± 0.65 yrs.). The study was conducted according to the principles of the Helsinki Declaration, as well as with the approval of the Ethics Committee of the Faculty of Sport and Physical Education, University of Belgrade (484-2).

Measures and procedures

All measurements were conducted between 2023 and 2024 in the morning hours (8:00 – 11:00) at the University of Belgrade, at the Faculty of Sport and Physical Education in the Methodological – Research Laboratory (MIL) in Belgrade. Body composition was measured using multi-segmental bioelectrical impedance analysis (InBody 720) following the standardized procedure described by Gaba et al., (2014). Body height was measured using a Martin anthropometer. The results were recorded with an accuracy of 0.1 cm (Nešić et al., 2015). Participants were instructed not to consume food and liquids in the morning of the measurement day, and to abstain from alcohol consumption and intense physical activity 12 hours before testing.

Indices and classifications

According to the World Health Organization (WHO, 2000), underweight was defined as $\leq 18.5 \text{ kg}\cdot\text{m}^{-2}$, normal weight as $18.5 \text{ kg}\cdot\text{m}^{-2} \leq \text{BMI} < 25 \text{ kg}\cdot\text{m}^{-2}$, overweight as $25 \text{ kg}\cdot\text{m}^{-2} \leq \text{BMI} < 30 \text{ kg}\cdot\text{m}^{-2}$, and obesity as $\text{BMI} \geq 30 \text{ kg}\cdot\text{m}^{-2}$. According to Dopsaj et al., (2020), female students underweight were defined as $\text{PBF} < 19.5 \%$, Normal 1 weight as $19.5 \% \leq \text{PBF} < 23.0 \%$, Normal 2 as $23.0 \% \leq \text{PBF} < 29.6 \%$, Overweight 1 as $29.6 \% \leq \text{PBF} < 31.4 \%$, Overweight 2 as $31.4 \% \leq \text{PBF} < 37.1 \%$, Obese 1 as $37.1 \% \leq \text{PBF} < 42.0 \%$, Obese 2 as $42.0 \% \leq \text{PBF} < 47.1 \%$ and Obese 3 as $47.1 \% \leq \text{PBF} < 52.8 \%$. For males 12–20% physiological (normal) values, 20–25% borderline overweight, >25% overweight (obese) (Bray et al., 2008). According to Peltz et al., (2010), FMI values of $6.6 \text{ kg}\cdot\text{m}^{-2}$ in men and $9.5 \text{ kg}\cdot\text{m}^{-2}$ in women were found to be indicative of obesity.

Variables

- Eight body composition variables were analyzed:
- Body height (**BH**), expressed in cm.
 - Body mass (**BM**), expressed in kg.
 - Body mass index (**BMI**) is calculated as Body weight / Body height in square, expressed in (kg·m) (Vukovic et al., 2022).
 - Percentage of body fat (**PBF**), expressed in %. The calculation of PBF was based on the formula developed by Durin & Womersley (1974).
 - Percentage of skeletal muscle mass (**PSMM**) calculated as Skeletal muscle mass / Body mass, expressed in % (Vukovic et al., 2022).
 - Skeletal muscle mass index (**SMMI**) is calculated as Skeletal muscle mass / Body height in square, expressed in kg·m (Vukovic et al., 2022).
 - Protein-fat index (**PFI**) is calculated as Protein / Body fat mass (Dopsaj et al., 2018).
 - Fat mass index (**FMI**) is calculated as Body fat mass / Body height in squares expressed in kg·m , (Peltz, 2010).

Statistical analyses

The data were analysed using descriptive methods. For all variables, the mean, standard deviation, coefficient of variation, minimum, maximum, and 95% confidence interval were calculated. The normality of the distribution of the results was determined by Kolmogorov-Smirnov test. All data analyses were conducted using IBM SPSS v.20 statistical software. The level of statistical significance was defined for the probability of 95%, i.e. p≤0.05.

RESULTS

The basic descriptive statistics of the examined body structure variables are shown in Tables 1 and 2.

Table 1. Descriptive statistics of male students' body composition.

Variables	Mean	SD	CV%	MIN	MAX	95% Conf. Int.		K-S p-value
						Lower	Upper	
BH (cm)	181.0	7.3	4.1	165.1	195.0	178.7	183.3	0.200
BM (kg)	76.8	8.90	11.59	55.70	93.20	73.96	79.58	0.200
BMI (kg·m ₂)	23.41	2.21	9.43	19.27	28.39	22.71	24.11	0.200
FMI (kg·m)	3.15	1.15	36.52	0.92	6.26	2.79	3.52	0.200
PSMM (%)	49.3	2.9	6.1	41.2	55.4	48.4	50.3	0.200
PBF (%)	13.3	4.2	30.9	4.6	23.7	11.9	14.5	0.133
PFI	1.51	0.73	48.32	0.64	4.18	1.28	1.74	0.000
SMMI (kg·m)	11.53	1.00	8.67	9.07	13.21	11.21	11.85	0.200

Legend: body height (BH); body mass (BM); body mass index (BMI); percentage of body fat (PBF); percentage of skeletal muscle mass (PSMM); skeletal muscle mass index (SMMI); protein fat index (PFI); fat mass index (FMI).

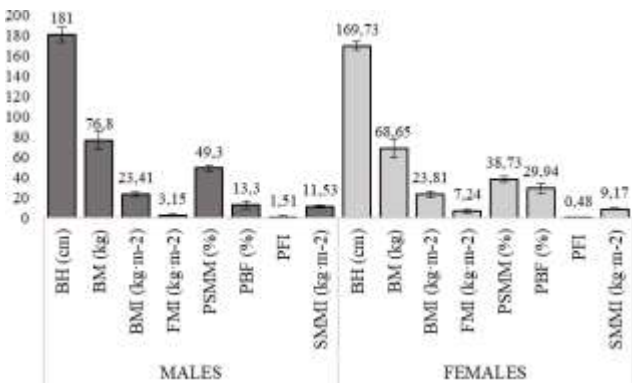
Table 2. Descriptive statistics of female students' body composition.

Variables	Mean	SD	CV%	MIN	MAX	95% Conf. Int.		K-S p-value
						Lower	Upper	
BH (cm)	169.73	4.19	2.47	161.50	175.50	167.18	172.25	0.200
BM (kg)	68.65	8.91	12.97	55.70	84.00	63.26	74.03	0.200
BMI (kg·m ⁻²)	23.81	2.89	12.17	19.05	28.97	22.07	25.57	0.200
FMI (kg·m)	7.24	1.98	27.44	3.86	11.63	6.04	8.44	0.200
PSMM (%)	38.73	2.91	7.52	32.67	43.34	36.96	40.48	0.200
PBF (%)	29.94	5.03	16.78	20.24	40.13	26.89	32.97	0.200
PFI	0.48	0.12	25.62	0.29	0.77	0.41	0.55	0.200
SMMI (kg·m)	9.17	0.85	9.23	7.86	8.99	8.66	9.68	0.200

Legend: body height (BH); body mass (BM); body mass index (BMI); percentage of body fat (PBF); percentage of skeletal muscle mass (PSMM); skeletal muscle mass index (SMMI); protein fat index (PFI); fat mass index (FMI).

In Table 1, higher values of CV% were observed for the variables FMI (36.52%), PBF (30.9%) and PFI (48.32%). The values for FMI and PBF indicate moderate variability in the data compared to the mean. Moderate variability indicates that there are differences between the individual values of FMI and PBF in the sample, but it is not as pronounced as for PFI, which has a CV% of 48.32%. The high CV% value for PFI indicates a significant difference between individual values in the sample, suggesting a wide range of values in the data. In this regard, the Kolmogorov-Smirnov test for PFI is significant (p<0.05). Using the histogram, it was found that there are 3 individual cases (extreme values) with higher PFI values. A closer examination of the database revealed that these extreme cases are extremely physically active and have a high proportion of muscle mass and protein in their bodies due to regular exercise and a proper diet. For all other variables, the Kolmogorov-Smirnov test indicates a normal distribution of the data (p>0.05). In Table 2, a moderate variability (CV=27.44%) of the data is observed for the variable FMI, while the other variables show a low variability in relation to the mean. The individual values for all other variables are close to the mean.

Figure 1. Descriptive statistics of female and male students' body composition.



DISCUSSION

This research aimed to determine the quantitative characteristics and present the profile of the physical status of male and female students at the Academy for National Security, defined using multisegmental bioelectrical impedance (BIA).

The average body mass of male students was 76.8 kg and height was 181.0 cm, while female students body mass was 68.65 kg and height was 169.73 cm, respectively (Table 1 and Table 2). The mean BMI for the total sample of female students was $23.82 \pm 2.89 \text{ kg}\cdot\text{m}^{-2}$ and for the male students $23.41 \pm 2.21 \text{ kg}\cdot\text{m}^{-2}$. These results show that the students have normal BMI values according to the World Health Organisation (WHO, 2000). The body fat percentage (PBF) of 29.94% for the female students in our study is higher than the female students of the Faculty of Special Education and Rehabilitation at the University of Belgrade (26.16%) (Dopsaj et al., 2018). According to the classification of Dopsaj et al., (2020), female students also fall into the overweight 1 category, as they are in a range between 29.6% and 31.4%. The average body fat percentage of male students is 13.3%, which indicates that the students have a physiologically normal body fat percentage. In the study on the morphological characteristics of female students at the University of Belgrade, which included 862 female students in the total sample (Dopsaj et al., 2020), it was found that the morphological status of these female students is at the level of individuals with normal BMI, with a double prevalence of underweight (6.85%), indicating poor nutrition, compared to obesity (3.13%), indicating overeating. The study examining the physical status of 734 students from the University in Italy (Zaccagni, 2014), found that men generally showed a decrease in body fat percentage (PBF), while women showed higher PBF values due to energy balance and sports preferences.

In the study by Dopsaj et al., (2020), descriptive data were presented for a sample of 8733 participants concerning gender, with mean PSMM scores for the sample (aged 18-29 years) being 49.27% for males and 41.29% for females. Similar results were observed for university students, with an average PSMM of 49.3%, while female students in our study had a slightly lower fat percentage of 38.73%. Also, the results of SMMI in the study by Dopsaj et al., (2020) are similar to the results of our study, where the values for female students were $9.17 \text{ kg}\cdot\text{m}^{-2}$ and for male students $11.53 \text{ kg}\cdot\text{m}^{-2}$. Considering that SMMI and PSMM are the most methodologically sensitive and accurate indicators of musculature in both sexes and indicate muscle mass independently of body size (Dopsaj et al., 2021), it can be assumed that male students have greater muscle mass. In this regard, a good SMMI is not sufficient for good health and performance if there is excessive adipose tissue, which is the case with female students at the Academy for National Security.

The results of the PFI for the total sample of female students were (0.48 ± 0.12) and for male students (1.51 ± 0.73) . On average, male students have a higher ratio of protein to fat in their bodies than female students. Similar results were obtained in the study by Dopsaj et al., (2018), in which, based on the average values of 110 students (with programmed training), the PFI was (1.837 ± 0.94) for male students and (0.735 ± 0.20) for female students. A lower PFI was observed in females, indicating less

contractile tissue (protein) than fatty tissue. This could indicate a lack of muscle mass, which is associated with poorer physical health and a lack of exercise.

Another parameter of body composition, FMI, is presented in the study by Dopsaj et al., 2021, with a total sample of 1937 women from Serbia. Specifically, the FMI for the age group (20-29) years was on average 5.84, while the FMI in our study is slightly higher at 7.24. Male students have an average FMI of 3.15, similar values to the study by Dopsaj et al., 2017, where the sample consisted of high-level competitors in two Olympic sports, judo, Greco-Roman wrestling and karate. This suggests that male students have FMI values at the level of elite athletes. This study has some limitations. First, the sample of participants included only first- and second-year students, so caution should be exercised when concluding other age groups. Second, only the initial measurements were taken, so body composition across the years of study was not examined. Future studies should include a larger number of participants and track body composition across all four years of the study. In view of the fact that the study by Beaudry et al., (2019) shows that male and female university students show unfavourable changes in diet and body weight during the first year of study, future research could investigate whether similar changes occur in students at universities in Serbia. Considering that physical activity is a mandatory part of the curriculum for students at the Academy for National Security, it could be beneficial to observe how physical activity affects students' mental and physical health.

CONCLUSION

Based on the results, it can be argued that the average basic morphological characteristics of male and female students at the Academy for National Security were as follows: body height (males: 181.0 ± 7.3 cm; females: 169.73 ± 4.19 cm), body mass (males: 76.8 ± 8.90 kg; females: 68.65 ± 8.19 kg), BMI (males: 23.41 ± 2.21 kg·m⁻²; females: 23.81 ± 2.89 kg·m⁻²), PBF (males: 13.3 ± 4.2 %; females: 29.94 ± 5.03 %), PSMM (males: 49.3 ± 2.9 %; females: 38.73 ± 2.91 %).

Regarding the results, it can be argued that students of both genders have normal BMI values. When considering the percentage of body fat (PBF) as a criterion for nutritional status, male students have normal levels of body fat, while female students fall into the overweight category. Based on the values of PSMM and SMMI, it can be concluded that both male and female students have muscle mass at the level of athletes. Multisegmental bioimpedance analysis shows that the measured samples of male and female students have an average level of Fat Mass Index (FMI), Protein Fat Index (PFI), and Skeletal Muscle Mass Index (SMMI) in the body at levels for males: (3.15 ± 1.15 kg·m⁻², females: 7.24 ± 1.98 kg·m⁻²); (males: 1.51 ± 0.73 , females: 0.48 ± 0.12) ; (males: 11.53 ± 1.00 kg·m⁻², females: 9.17 ± 0.85 kg·m⁻²), respectively. Based on the results, it can be concluded that the current morphological status of students at the Academy for National Security falls within the category of the population with average anthropometric and morphological status of students at the University of Belgrade, with females having a higher percentage of body fat, exceeding the biological maximum for females.

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