



BODY COMPOSITION IN MALE PHYSICAL EDUCATION UNIVERSITY STUDENTS IN VIEW OF THEIR PHYSICAL ACTIVITY LEVEL

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ABSTRACT

Purpose. Body composition and fat distribution is specific for particular populations and social groups. However, one factor that significantly affects body composition is physical activity. The aim of the study was to assess the various components of body composition in male physical education students with regard to their physical activity level. **Methods.** A detailed questionnaire survey on physical activity was administered to 252 male students. Based on their responses, the participants were placed into two groups engaged in either moderate or vigorous physical activity. Anthropometric measurements included measures of body height and mass and also skinfold thickness. Body composition was assessed by bioelectrical impedance analysis. Statistical analysis was performed by comparing the groups' mean values, standard deviations, and percentages of the components of body composition. **Results.** The groups did not differ significantly for mean body height and mass. No statistically significant differences were found in the absolute amounts of the various components of body composition (except for fat mass) between the groups. Both groups had 61.5 kg of fat-free mass (constituting 80.6% of body mass for the vigorously active and 78.7% of body mass for the moderately active students) and both had 44 kg of muscle mass (constituting 58.3% and 56.1% of body mass, respectively). Students who declared to be involved in vigorous physical activity had 2 kg less and 2% lower fat mass than those involved in moderate physical activity (based on BIA measurements). Measures of skinfold thickness found more subcutaneous fat tissue in the vigorously active group, but the use of a fat index based on body height found them to present less fat. **Conclusions.** The difference in fat content between physical education students who were more or less physically active was found to be 2 kg and 2%. The results found that physical activity level was not associated with body height, body mass, and the absolute amounts of the other studied components of body composition.

Key words: body components, BIA method, skinfolds, BMI, fatness, moderate and vigorous activity

Introduction

The effects of increased physical activity include changes in body composition [1–4]. The scale of observed changes depends on the type of physical activity or sport one is engaged in as well as the individual features and predispositions of that individual. These include sex, age, somatotype, and the specific dynamics of one's metabolic processes. Physical education university students – with regard to the specific character of their studies – are expected to feature different body composition when compared with the general population. However, recent changes in higher education dynamics including the enrollment structure and overall education system may have influenced the size of these differences.

The most accurate methods of measuring body composition include magnetic resonance imaging and computed tomography [5]. Unfortunately, these methods are expensive and mainly applied in medical diagnostic fields – their wide application in population-based studies is difficult to justify. However, the use of bioelectrical impedance analysis (BIA) is gaining popularity as a relatively simple and non-invasive method for the

indirect estimate of total body water, body fat, and muscle mass. Due to its confirmed high repeatability, BIA has been widely used in population studies as well as in replicating research [6–7] to allow a comparative analysis of the results of studies on different populations. BIA determines the resistance and reactance of body tissues to the flow of an electric current, which is of low charge (< 1 mA), imperceptible to the subject, and at a frequency of at least 50 kHz. A more precise description of BIA and its methodology can be found in Kyle et al. [8] and Lewitt et al. [9].

The aim of the present study was to examine body composition with BIA in a group of male university students studying physical education with regard to their physical activity level. In addition, measurements of subcutaneous fat were performed. The study intended to identify those components of body composition that could differentiate those who declared being involved in vigorous physical activity and those in moderate physical activity.

The presented study is part of longitudinal survey attempting to detect secular trends in the body tissue composition and somatotypes of students attending the University School of Physical Education in Wrocław, Poland [10].

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Material and methods

The study material consisted of cross-sectional anthropometric measurements, an assessment of body composition, and responses to a questionnaire survey. The population sample consisted of 252 male students aged 19–25 years attending the University School of Physical Education in Wrocław, Poland, during the 2009–2010 academic year. All were studying either Physical Education or Physiotherapy. The participants' mean age was 20.9 ± 2.0 years, mean body height 180.5 ± 6.7 cm, and body mass 77.3 ± 10.8 kg.

Body height was measured to the nearest 0.1 cm using the methodology outlined by Martin and Saller [11] with the use of a GPM anthropometer (Siber Hegner Machinery Ltd., UK). Body fat was measured by skin-fold thickness (subscapular, triceps, forearm, suprailiac, abdominal, and calf) with a Tanner/Whitehouse skin-fold caliper (Holtain, UK) with 0.2 mm graduation. Body mass was measured with an electronic weighing scale with an accuracy of 0.1 kg.

The anthropometric measurements were then used to calculate a Subcutaneous Fat Index (SFI), an index proposed by the present authors that takes into account trunk and extremity skinfolds and body height. It was believed that the SFI would provide a more unambiguous form of reporting for later interpretation than the other popular indexes currently used for evaluating body fat.

$$\text{SFI} = \frac{\text{ssSF} + \text{tSF} + \text{fSF} + \text{aSF} + \text{siSF} + \text{cSF (mm)}}{\text{body height (cm)}} \cdot 100$$

ssSF – subscapular skinfold, tSF – triceps skinfold, fSF – forearm skinfold, siSF – suprailiac skinfold, aSF – abdomen skinfold, cSF – calf skinfold

The participants' body build was also determined by calculating the Body Mass Index (BMI) following the World Health Organization's (WHO) guidelines.

Measurements of body composition by bioelectrical impedance analysis (BIA) were performed with a BIA-101 Anniversary Sport Edition analyzer (Akern, Italy) in standard conditions (in the supine position on an empty stomach). Analysis of tissues was performed with Bodygram 1.3.1. software packaged with the Akern analyzer. The percentages of the following components of body composition were measured: fat mass (FM), fat-free mass (FFM), total body water (TBW), extracellular water (ECW), intracellular water (ICW), muscle mass (MM), body cell mass (BCM).

The students were administered a self-tailored detailed survey regarding the regularity, frequency, and types of physical exercise/physical activity they performed. Following WHO guidelines [12], this included all leisure activities and physical activity performed during curricular activities. The reliability and repeatability of the ques-

tionnaire was previously demonstrated in unpublished works. Based on their responses, the sample was divided into two groups depending on physical activity level: those who performed moderate activity (irregular walks, jogging, swimming, etc., $n = 85$) or vigorous activity (regular physical exercise or training more than twice a week, $n = 167$).

Statistical analysis included calculating the arithmetic means and standard deviations of the anthropometric measurements. The Shapiro-Wilk test was used to check the distribution of the examined variables for normal distribution. Levene's test was applied to assess the equality of variances of both groups (moderate and vigorous activity). The significance of differences was checked with Student's t test, and the differences between the percentages of the analyzed body components were checked with the Two-Proportion z Test. The level of statistical significance was set at $p = 0.05$. All statistical calculations were performed with Statistica 9.0. software (Statsoft, USA), whereas Office Excel 2003 (Microsoft, USA) was used to create graphical representations of the data.

The study was approved by the Ethics Committee of the University School of Physical Education in Wrocław, Poland and written informed consent was obtained from all participants.

Results

No statistically significant differences were found for body height (Student's $t = 0.81$; $p = 0.4165$) or body mass (Student's $t = -1.66$; $p = 0.0979$) between the students engaged in moderate and vigorous physical activity. However, it should be noted that the more physically active participants had slightly lower body mass than the less active ones (76.5 kg vs. 79.0 kg, respectively).

The results of body composition analysis are summarized in Table 1 and Figure 1. Those students declaring higher levels of physical activity did not differ significantly for fat-free mass from their less physically active counterparts, although the percent of fat-free mass was 2% greater for students engaged in vigorous physical activity. The two groups differed significantly in the absolute amount of fat mass. The students engaged in vigorous physical activity had 2 kg and 2% less fat mass than those engaged in moderate physical activity. The more physically active students featured 2% greater muscle mass than their less active counterparts, but the difference was not significant in either the absolute or relative amount of muscle mass between the two groups. The more physically active students also featured better hydration values than the other group. Differences in the range of 1.0–1.5% were found for total body water, extracellular water, and intracellular water content. Although no statistically significant differences were observed in the absolute amount of total body water, the more physically active students had less extracellular water and more

Table 1. Means and standard deviations of the components of body composition (in kg) estimated by BIA, including Student's *t* test *p* values

Body components (kg)	<i>M</i> ± <i>SD</i>		Student's <i>t</i> test <i>p</i>
	vigorous activity <i>n</i> = 167	moderate activity <i>n</i> = 82	
FFM	61.5 ± 7.9	61.5 ± 6.5	0.9766
FM	15.0 ± 5.1	17.2 ± 6.0	0.0038
MM	44.5 ± 6.1	43.8 ± 5.0	0.3765
TBW	45.0 ± 5.7	45.0 ± 4.7	0.9716
ECW	18.1 ± 2.4	18.6 ± 2.6	0.1630
ICW	26.9 ± 3.6	26.5 ± 3.1	0.3522
BCM	36.8 ± 5.1	36.1 ± 4.3	0.3114

FFM – fat-free mass, FM – fat mass, MM – muscle mass, TBW – total body water, ECW – extracellular water, ICW – intracellular water, BCM – body cell mass; statistically significant differences marked in bold

Table 2. Means and standard deviations (in mm) of skinfold thickness measurements, including Student's *t* test *p* values

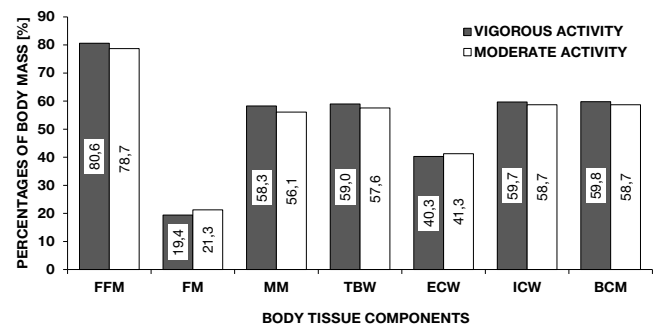
Skinfold (mm)	<i>M</i> ± <i>SD</i>		Student's <i>t</i> test <i>p</i>
	vigorous activity <i>n</i> = 167	moderate activity <i>n</i> = 82	
Subscapular	9.5 ± 3.1	9.0 ± 2.6	0.3421
Triceps	5.5 ± 2.9	5.1 ± 2.6	0.4000
Forearm	3.8 ± 2.1	3.5 ± 1.0	0.3836
Suprailiac	9.0 ± 5.2	8.7 ± 3.6	0.7373
Abdominal	10.0 ± 5.9	9.2 ± 4.2	0.4409
Calf	5.6 ± 2.8	5.4 ± 2.3	0.7529

Table 3. Means and standard deviations of BMI and SFI, including Student's *t* test *p* values

Index	<i>M</i> ± <i>SD</i>		Student's <i>t</i> test <i>p</i>
	vigorous activity <i>n</i> = 167	moderate activity <i>n</i> = 82	
BMI (kg/m ²)	23.6 (2.5)	24.2 (2.9)	0.0657
Subcutaneous Fat Index (SFI)	28.4 (16.0)	30.7 (17.3)	0.4371

intracellular water than the students engaged in moderate activity. The former also had a clearly higher percentage of body cell mass but only a slightly higher absolute amount of this component. The results of the Two-Proportion *z* Test did not indicate any statistical significance of the observed differences in the relative amounts of the components of body composition.

The two groups did not differ significantly for mean subscapular, triceps, forearm, suprailiac, abdominal, and calf skinfold thickness (Tab. 2). It must be noted,



FFM – fat-free mass, FM – fat mass, MM – muscle mass, TBW – total body water, ECW – extracellular water (% of TBW), ICW – intracellular water (% of TBW), and BCM – body cell mass; differences in percent body composition of the particular components were found to be not statistically significant with *p* values of 0.70–0.90 in the Two-Proportion *z* Test

Figure 1. Body composition estimated by BIA as a percentage of body mass

however, that the more active students had slightly thicker skinfolds (differences ranging from 0.5 to 1.0 mm). However, the Subcutaneous Fat Index (SFI), adopted to measure the ratio of subcutaneous fat to body height, revealed lower body fat for those students engaged in vigorous physical activity (Tab. 3).

The mean BMI values for both groups showed that the more active students could be characterized as having a more slender body than the students involved in moderate physical activity; however, this difference was also not statistically significant (Tab. 3).

Discussion

The effects of vigorous physical activity on the reduction of body fat as well as the fact that physically active students generally have lower adiposity levels have been well-documented [13–15]. Researchers have studied this issue in studies on various populations and age groups [2, 16–17].

The present study found that the difference in body fat content between the two groups of male physical education students engaged in different physical activity levels was 2 kg and 2%. A previous study by Pietraszewska et al. [18] revealed a 3% difference in fat mass between more (19.3%) and less (22.5%) physically active students from the same region. Furthermore, the percentage of body fat (19.4%) found for the students engaged in vigorous physical activity in this study is consistent with the results of Pietraszewski et al. [19], who noted 19.6% body fat using the same type of body composition analyzer also on a group of physical education students from the same region of Poland. However, according to a recent study performed at the University of Physical Education in Warsaw, Poland, this group of physical education students – regardless of their level of physical activity – had about 12% fat mass [20], which is less than the students from the present study. This inconsistency may stem from using different methods of analyzing body composition. Swartz et al. [21] noted

that less active students, i.e., those performing fewer than 2.5 hours of aerobic activity per week had 4% (measured by hydrostatic weighing) or 1.5% (by BIA) more body fat than vigorously active students. A similar result was found between more or less physically active female physical education students, with a 2% difference found in measures of fat content [22].

No significant differences were observed in the thickness of skinfolds between the participants engaged in vigorous physical activity and those in moderate activity. Pietraszewska et al. [18] found that more physically active students presented thinner triceps and suprailiac skinfolds. It seems that more active students examined in the present study had slightly more absolute subcutaneous fat, although most skinfolds were thicker by only about 0.5 mm than those who were less active. Trunk skinfold thickness was about half of that measured on the extremities.

The values calculated using the Subcutaneous Fat Index showed that subcutaneous fat in relation to body height was lower in the more physically active students than those less active. This was also confirmed by the lower mean BMI scores, lower body mass, and more slender body build for the more active students than the less active individuals. Previous studies also revealed a reduction in skinfold thickness in men and women after several weeks of physical training [23]. The relationship between skinfold thickness and body mass and height has been well-documented [24], finding that the volume of subcutaneous fat depends on body size and its potential to be reduced is limited.

The results also found that the two groups differed from each other in terms of body composition as a percentage of each individual component. The more active students had 2% greater muscle mass as well as body cell mass and intracellular water content than their less active counterparts. Interestingly, Convertino [25] reported an increase in body fluids after training, while Pickering, Fellmann, and Morio [26] did not find any changes in total body water in a group of older students after several weeks of training, observing only a decrease in fat mass. The students in the present study were found with a generally low level of hydration (about 58%). The more physically active students also had less extracellular water and more intracellular water than the students performing physical activity at a moderate level. Similar hydration values were also observed by Pietraszewski et al. [19], finding more active students to be characterized by higher hydration levels (TBW = 59.1%) compared with less active students (TBW = 56.7%) [18]. Nonetheless, it needs emphasis that the differences in body composition as a percentage of each component observed in the present study were not statistically significant. This finding may be due to the small size of the study groups and the constraints of using the Two-Proportion z Test.

Conclusions

– Male students studying physical education who declared to be involved in vigorous of physical activity were found to have 2 kg and 2% less fat mass than those engaged in moderate levels of physical activity.

– A higher level of physical activity was correlated with a higher percentage of fat-free mass, muscle mass, body cell mass, total body water, and intracellular water.

– No differences were found in the thickness of skinfolds between those students involved in moderate and vigorous activity. However, the level of relative subcutaneous fat (in relation to body height) was smaller in the more active students.

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