

COMPARISON OF ADIPOSE AND MUSCLE TISSUE CONTENT AND PHYSICAL ACTIVITY LEVEL OF FEMALE STUDENTS FROM THE ACADEMY OF PHYSICAL EDUCATION AND THE UNIVERSITY OF SILESIA IN KATOWICE

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- fat tissue,
- bioelectrical impedance analysis (BIA),
- physical activity,
- International Physical Activity Questionnaire (IPAQ)

Abstract:

Introduction. Physical activity and dietary habits are some of the most important elements of lifestyle affecting to proper functioning of the human body. The progress of civilization and changes taking place in the contemporary world are reflected in physical activity and body composition, especially among young people.

The aim of the work. The purpose of the study was to compare levels of physical activity, contents of adipose, muscle tissue and time spend in the sitting position of the females studying at two different profiles of college.

The material and the methodology. The study group consisted of 12 female students of the Faculty of Physiotherapy, the Academy of Physical Education in Katowice, whereas the control group consisted of 12 female students of the Faculty of Biology and Environmental the University of Silesia in Katowice. The measurement of body composition was made by Tanita BC-730, while the measuring of the level of physical activity was performed using short version of the International Physical Activity Questionnaire.

Results. Studies have shown statistically significant differences in the values of: BMI ($p < 0,01$), % of adipose and muscle tissue ($p < 0,001$) between groups. Significant differences in levels of physical activity was also found: high intensity ($p < 0,01$) moderate intensity ($p < 0,05$), low intensity of physical activity ($p < 0,01$) and energy expenditure ($p < 0,001$). Time spent in a sitting position also distinguished groups ($p < 0,01$).

Conclusions. Levels of physical activity and selected body composition parameters significantly differentiated groups of students. The program of biotechnology should include topics on regular and targeted physical activity.

INTRODUCTION

Physical activity, dietary habits, rest are some of the most important elements of lifestyle effecting-wholesome and proper functioning of the human body [20,21,47]. Physical activity combined with a balanced diet is essential in the modern world for health and survival [44]. The progress of civilization and changes taking place in the contemporary world are reflected in physical activity and body composition, especially among young people [18]. An insufficient level of physical activity and sedentary lifestyle are independent risk factors of diseases such as: obesity, diabetes, hypertension, dyslipidemia, osteoporosis, arteriosclerosis and coronary heart diseases [3,13,18,24,27,41,42,51].

The increasing prevalence of overweight and obesity in children and young people is becoming a serious social and health problem in the recent years [15,19,45,49,56]. Therefore, a preventive role of physical activity [5,7,23,25,33] and diet [31,37,56,57,59] should be emphasized. According to Łaszek et al. (2011) practicing physical activities and respecting principles of proper nutrition are the most important health behaviors [35]. Besides the fact that they are one of the elements of a healthy lifestyle, they are also primary determinants of physical fitness, influencing feasibility of the study program. According to Górska-Kłęk et al. (2011), students in Poland are aware of the benefits of the above-mentioned components of a healthy lifestyle, but that knowledge is not reflected in their health-promoting behaviors [21]. Other authors [30,44] noticed that the above-mentioned pro-health attitudes are conditioned by an influence of the environment (in this case university), which shapes attitudes reflected in the way students spend their leisure time. It is worth noting that students' lifestyle, level of physical activity and body composition significantly differentiate students from each other. The students from the Academy of Physical Education have a greater awareness of healthy behaviors' benefits compared to students who study subjects not directly related to physical activity. These conscious health behaviors are evidently caused by the nature of undertaken studies [47].

The analysis of physical activity level, body composition and nutritional status has recently gained importance due to an increasing prevalence of overweight and obesity among children and adolescents. Measurements of body composition are especially important in the assessment of nutritional status and the risk of diseases related to abnormal level of adipose tissue [29,32,48]. One of the body composition analysis methods is the bioelectrical impedance method (BIA) [17]. BIA measures the impedance or resistance of tissues like adipose and muscle, to the signal (electrical low intensity current) as it travels through the water that is found in muscle and fat [10,19,34,48]. BIA method is a reliable, safe and effective way to study the body composition of the healthy and the sick, individuals at different stages of ontogenesis, different levels of physical activity or training experience [1,2,12,16,25,26,32,36,43].

Apart from the body composition measurement, an assessment of physical activity level is also significant. To evaluate a level of physical activity among children and adolescents, young adults and older individuals, the International Physical Activity Questionnaire (IPAQ) can be used [6,8,11,22,40,46,50,53]. In addition, IPAQ is widely used in studies of physical activity worldwide [11,28,38,54,55]. Studies of Deng et al. (2008), Guedes et al. (2005) and Tran et al. (2013) have shown a high reliability of the IPAQ questionnaire in assessing a physical activity level [14,22,55].

Taking into account the characteristics of the study programs and profiles of the Academy of Physical Education as well as University of Silesia it was assumed that the analyzed groups of female students will be significantly different from each other in the evaluated parameters (level of adipose and muscle tissue and levels of physical activity). It was also hypothesized that physiotherapy students will spend less time in the sitting position in comparison to biotechnology students.

THE AIM OF THE WORK

The purpose of this study was to compare levels of physical activity, contents of adipose and muscle tissue as well as time spend in the sitting position of the females studying physiotherapy at The Academy of Physical Education in Katowice and the female students from the University of Silesia in Katowice from Faculty of Biology and Environmental (studying biotechnology).

THE MATERIAL AND THE METHODOLOGY

The study group consisted of 12 female students of the Faculty of Physiotherapy, the Academy of Physical Education in Katowice, while the control group consisted of 12 female students of the Faculty of Biology and Environmental the University of Silesia in Katowice. Participants were selected randomly, volunteered and gave their formal consent to the study. Body composition, basic anthropometric parameters were taken and the physical activity level questionnaire was completed on the same day. Body height was measured to the nearest 0,5 cm and body weight - to the nearest 0,5 kg. Basic parameters characterizing analyzed students are given in Table I.

Table 1. Anthropometric characteristics (mean±SD) analyzed groups of students

Data	Students from the Academy of Physical Education in Katowice n=12	Students from the University of Silesia in Katowice n=12
Age [lata]	23,25±0,45	23,5±0,52
Body height [cm]	166,42±4,27	168,17±6,49
Body weight [kg]	52,94±5,22	61,07±4,97
BMI [kg/m²]	19,1±1,54	21,62±1,68

SD - standard deviation, n - number of students, BMI - body mass index

Body composition measurements were conducted using the method of bioelectrical impedance, by means of body composition analyzer Tanita BC-730 (system of 4 electrodes, foot-foot), frequency of 50 kHz and current of 0,5 mA. Females were informed about the test conditions (should proceed on measurement after: the night rest, a light meal without coffee, not to consume alcohol and not to smoke for 24 hours before the measurement and not to perform vigorous exercise before; furthermore studied women had no period during the test). After disinfection of feet the students were asked to stand on the scale Tanita BC-730 and to place their feet on the two electrodes. Then basic data such as: age, body weight, body height was introduced. After three seconds the results of body composition parameters appeared. The measurements included the parameters such as: body weight [kg], adipose tissue [%] and muscle mass [kg]. To calculate adipose tissue mass [kg] of analyzed students value of adipose tissue [%] and body weight [kg] was multiplied, for example:

$$0,186 \times 51 \text{ [kg]} = 9,5 \text{ [kg]},$$

where: 18,6 % of adipose tissue, 51 kg of body weight.

In turn, to calculate the percentage of muscle tissue the ratio was used:

$$\text{muscle tissue mass [kg]} - x$$

$$\text{body weight [kg]} - 100\%.$$

To assess physical activity level of the female students the short version of the questionnaire IPAQ (International Physical Activity Questionnaire) was used. IPAQ contains 7 questions referring to all types of physical activity undertaken in the last 7 days (time and duration), linked both to everyday life, occupational work and leisure time [60]. In addition, information about respondents' time spent on high/moderate intensity activity, walking and sitting position was collected. In the terminology of the IPAQ, high intensity of physical activity is for example: carrying heavy objects, aerobics, fast running or fast cycling. Moderate physical activity is defined as, for example: carrying lighter loads, cycling at a normal pace or playing volleyball. Each of these types of activity were expressed in MET (metabolic equivalent), a measure of energy consumption during exercise. 1 MET is energy consumption of calories per 1 kilogram of body weight per 1 hour calm seat (kcal/kg/hr). For intense activity MET unit is 8 MET, for moderate - 4 MET and for walking is 3,3 MET [9]. Total energy expenditure was calculated from multiplying a frequency, a time duration and an

exercise intensity corresponding to its unit expressed as MET, which gave a total score of MET-minutes/week.

Means and standard deviations were calculated for analyzed parameters'. Each continuous variable was evaluated for compliance of its distribution with a normal distribution (histograms evaluation, Shapiro-Wilk test). Because measured characteristics showed deviated from the normal distribution (distribution extremely asymmetrical), the analysis procedure was applied by ANOVA in univariant. The significance of differences between means was compared by post - hoc - Bonferroni test. The lowest level of significance was set at $p < 0,05$. All calculations were performed using Statistica (StatSoft Poland, 10.0).

RESULTS

A comparative analysis of the mean values of body mass index (BMI) and level of adipose and muscle tissue [%] of female students from the Academy of Physical Education and the University of Silesia was presented in the table II . Results presented in the table indicate that female students of Physiotherapy Faculty at Academy of Physical Education are characterized by a lower body mass index compared to BMI obtained by the students from the University of Silesia (19,1 vs 21,62). The difference between described parameter in both groups is statistically significant ($p < 0,01$). In addition, a statistically significant difference in the level of adipose tissue between female students from the Academy of Physical Education (18,01%) and female students from the University of Silesia (26,92%) was demonstrated. Described difference was significant at $p < 0,001$. Students from the Academy of Physical Education have a higher percentage of muscle tissue in the body which is 77,92% and female students from control group - 69,4% (significant difference at $p < 0,001$).

Table 2. Comparison of body mass index BMI, adipose and muscle tissue (mean±SD) in analyzed groups of students

Parameter	Students from the Academy of Physical Education in Katowice n=12	Students from the University of Silesia in Katowice n=12	<i>p</i>
BMI [kg/m²]	19,1±1,54	21,62±1,68	0,01
Adipose tissue [%]	18,01±3,37	26,92±2,96	0,001
Muscle tissue [%]	77,92±3,12	69,4±2,85	0,001

BMI - body mass index, SD - standard deviation, % - percent, , n - number of students , *p* - level of significance

Data collected in Table III. contain a comparative analysis between the mean values of physical activity levels and time spent in a sitting position by students from the Academy of Physical Education and students from the University of Silesia. Significant differences between the study and control group are presented in all levels of physical activity performed by female students, total energy expenditure expressed in MET-minutes/week, as well as in time spent in a sitting position [minutes/week]. Students from the Academy of Physical Education are characterized by more than three times higher energy expenditure in high intensive efforts, compared with women from the control group - 4960 vs 1560 [MET-minutes/week], $p < 0,01$. Significant differences between the analyzed groups can be also observed in moderate and low intensity efforts, where students of the Faculty of Physiotherapy have twice higher energy expenditure compared to the female students of the Faculty of Biology and Environmental, respectively - 2320 vs 1081,67 and 2582,25 vs 1285,62 [MET-minutes/week]. For the moderate exercises a significant difference observed between the groups was at $p < 0,05$, while for the low intensity efforts at $p < 0,01$. Total energy expenditure [MET-minutes/week] also differentiates studied groups of students. The analysis of this

variable shows that the Academy of Physical Education' female students have two and a half times higher value of energy expenditure. In research group this parameter is equal to 9862,25 [MET-minutes/week], while in control group - 3927,29 [MET-minutes/week]. The difference mentioned above, is statistically significant ($p < 0,001$).

The last variable that significantly differentiates two analyzed groups of students is the time that they spent in a sitting position, measured in hours/week. Students from the University of Silesia spent 1950 minutes/week in this position, while females from the Academy of Physical Education a little less than 12 hours, exactly 1225,2 minutes per week. The difference between the studied female students is significant at $p < 0,01$.

Table 3. Comparison of level a physical activity level and time spent in a sitting position (mean±SD) in analyzed groups of students

Level of physical activity	Students from the Academy of Physical Education in Katowice n=12	Students from the University of Silesia in Katowice n=12	<i>p</i>
High intensity physical activity [MET-minutes/week]	4960±3072,36	1560±1394,74	0,01
Moderate intensity physical activity [MET-minutes/week]	2320±1512,13	1081,67±1261,01	0,05
Low intensity physical activity [MET-minutes/week]	2582,25±762,72	1285,625±977,33	0,01
Total physical activity [MET-minutes/week]	9862,25±2867,94	3927,29±2361,59	0,001
Sitting position [minutes/week]	1225,2±325,2	1950±658,5	0,01

SD - standard deviation, n - number of students, *p* - level of significance, MET - metabolic equivalent (1 MET=3,5 ml O₂/kg body mass/min or 1 kcal/kg/hr or 4,184 kJ/kg/hr

DISCUSSION

The present study showed that female students of the Faculty of Physiotherapy of the Academy of Physical Education in Katowice were characterized by significantly higher levels of physical activity compared to female students of the University of Silesia. This result certainly conditioned lower body mass index and more favorable proportion of muscle and adipose tissue in the research group students. According to Czajkowska et al. (2009) and Myszkowska-Ryciak et al. (2011) students from the Academy of Physical Education are characterized by a higher level of physical activity in relation to students from other universities [13,39].

Socha et al. (2010) analyzed the anthropometry and the content of body fat of young, non-obese 52 female and 17 male students of the Faculty of Physiotherapy, from the University of Physical Education in Wrocław [52]. The results showed that the students were characterized by a medium level of physical activity. For the purpose of this paper women' results will be discussed. Mean age of the surveyed females was 24,07±1,47 [years], body height - 166,32±6,80 [cm], body weight - 59,30±9,33 [kg], body mass index - 20,74±1,70 [kg/m²]. The percentage of adipose tissue was determined using 3 body composition analyzers based on bioimpedance analysis of tissues (Akern 101/S, Soehnle Body Balance Comfort F5, Omron BF 306) and the near-infrared interactance method (measuring device - FUTREX 6100A/ZL). Body composition analyzers gave different results, within the range of 23,82-

29,22 [%]. To make a comparative analysis of the results in present work the results which Socha et al. (2010) obtained using body analyzer Akern101/S (an electrode system hand-foot) will be discussed, due to the fact that Tanita BC-730 as well as Akern101/S work on the same system of electrodes. The mean value of the study participants' adipose tissue body content reached $29,22 \pm 2,52$ [%]. Significant similarities of anthropometric parameters between the group of female students from Wrocław and two groups of women in our work are noted. In addition, there is a significant difference in the amount of body fat between the groups of students representing the Faculty of Physiotherapy in Wrocław and the Academy of Physical Education in Katowice. A difference in the percentage of body fat is also observed in the group studied by Socha et al. (2010) and the undergraduate students from the University of Silesia in Katowice. The authors emphasized that factors such as: a state of the body hydration, as well as a level of respondents' physical activity have a major influence on the measurement results. The above factors could affect the similarities and the differences found in the results of the analyzed groups of students.

Kęska et al. (2012) analyzed body composition of 65 female and 109 male students of the Faculty of Physical Education from the Academy of Physical Education in Warszawa [29]. For the purpose of this study the results that authors obtained in women will be analyzed. The average age of female students was $20,5 \pm 3,1$ [years], body height - $168,3 \pm 6,26$ [cm], body weight - $60,8 \pm 6,83$ [kg] and body mass index - $21,4 \pm 1,94$ [kg/m^2]. Authors assessed level of adipose tissue using tetrapolar body composition analyzer, as well the measurement of skinfolds. The average percentage of females' body fat measured by bioelectrical impedance analysis was $21,9 \pm 5,3$ [%]. The difference in a body fat percentage between the groups of students surveyed by Kęska et al. (2012) and female students of the Academy of Physical Education in Katowice is irrelevant, which may result from a similar level of physical activity presented by the groups of undergraduates studying at the Academies of Physical Education. In addition, women examined by Kęska et al. (2012) obtained similar values of body weight and body mass index in relation to the students of the University of Silesia in Katowice. The mean value of adipose tissue among female students from the Academy of Physical Education in Warszawa was significantly lower compared to the value of adipose tissue characterizing students of the University of Silesia. This result could be related to the different educational profiles.

Zadarko et al. (2011) evaluated physical activity level of 1957 women aged 19-26 [years old], educating in Podkarpackie Voivodeship [58]. The study group was various and consisted of: physical education, nursing and midwifery students, people studying medical professions (public health, medical rescue) and different profiles identified as "other" (humanities, mathematics and natural sciences, polytechnic, law and administration, tourism and recreation). The groups' anthropometry and body composition were analyzed using analyzer Tanita TBF 300. Authors results indicated that physical education students showed the highest mean value of body weight - $59,2 \pm 7,6$ [kg], the lowest body mass index (second in order) - $21,1 \pm 2,4$ [kg/m^2] and the lowest fat level - $22,3 \pm 6,3$ [%]. For nursing and midwifery students mean values were: body weight - $58 \pm 9,9$ [kg], body mass index - $21,3 \pm 3,3$ [kg/m^2], percentage of body fat - $23,3 \pm 7,2$ [%], while for the other medical profiles average values were: $58,7 \pm 9,3$ [kg] body weight, body mass index - $21,2 \pm 2,9$ [kg/m^2] and $23,5 \pm 6,6$ [%] adipose tissue. The 'other' profiles students were characterized by mean value of body weight - $57,8 \pm 9,3$ [kg], body mass index - 21 ± 3 [kg/m^2] and content of adipose tissue - $22,7 \pm 6,9$ [%]. The results obtained by the authors present the most favorable percentage of adipose tissue in the group of physical education students. Therefore, the level of adipose tissue and body mass index of these females is different from the results obtained by the students from the research group of the Academy of Physical Education in Katowice. Students of the University of Silesia, in turn, had more similar results in body weight and body mass index in relation to wom-

en studying other than physical education profiles. However, it is noted that these students had a significantly higher percentage of body fat compared to the women participating in the Zadarko et al. (2011) study. This difference may be related to the analyzed students' diet or intensity of undertaken physical activities. It is also worth mentioning that Zadarko et al. (2011) in order to assess students' physical activity used the questionnaire Minnesota (MILTPAQ). The analysis of the results showed that female students were characterized by an average level of physical activity. Authors emphasized that females preferred light intensity of physical activities and only physical education students chosen high intensity efforts.

Czajkowska et al. (2009) analyzed anthropometry, cardio-respiratory capacity and physical activity level of 75 female students and 87 male students of the Academy of Physical Education in Warszawa [13]. Mean age of female students was $20,2 \pm 1,1$ [years], body height $167,5 \pm 5,4$ [cm], body weight $60,1 \pm 7,5$ [kg] and body mass index $21,4 \pm 2,4$ [kg/m^2]. The average percentage of body fat measured by Tanita BC-418 was $23,1 \pm 4,9$ [%]. The average value of energy expenditure determined by the Seven-Day Physical Activity Recall (SDPAR) questionnaire characterized students from the above publication at $8,4 \pm 5,3$ [calories/kg/day]. The authors noted that the Academy of Physical Education' students are characterized by regular physical activity resulting from the specificity of the studies. It was confirmed in the comparison of the two groups involved in the analysis. In addition, students from the Warszawa Academy of Physical Education obtained similar results to the females studying at the Academy of Physical Education in Katowice and moreover, better results than students of the Faculty of Biology and Environmental the University of Silesia.

Baj-Korpak et al. (2010) using short version of the International Physical Activity Questionnaire (IPAQ), analyzed physical activity levels of 90 individuals who were divided into 4 socio-professional groups - pupils, students, teachers and tutors [4]. One of the research groups consisted of 16 female and 13 male studying tourism and recreation at the University in Biała Podlaska. Female students had $54 \pm 6,6$ [kg] of the mean body weight, body height - $165,8 \pm 6,0$ [cm] and body mass index - $19,8 \pm 1,8$ [kg/m^2]. Male students had $79,6 \pm 7,3$ [kg] of the mean body weight, body height - $180,0 \pm 4,9$ [cm] and $24,4 \pm 1,8$ [kg/m^2] body mass index. Both groups were subjected to combined analysis of physical activity in the last 7 days. Mean values of physical activity energy expenditure were: $1469,0$ [MET-minutes/week] on intensive efforts, $920,6$ [MET-minutes/week] on moderate activities, $3234,6$ [MET-minutes/week] on the efforts of low intensity (walk) and total energy expenditure amounted to $5624,2$ [MET-minutes/week]. Authors results show that these students are characterized by executing less physical activities of high and moderate intensity, while they expend more energy on the low intensity physical efforts, compared to students of the Academy of Physical Education in Katowice. In addition, undergraduates of tourism and recreation devote a little more than 324 [minutes] per day of time spent in a sitting position, which is less compared to the students of the University of Silesia, who sat during the day for approximately 390 [minutes]. However, students of the Academy of Physical Education in Katowice spent about 245 [minutes] per day in a sitting position. It should be also emphasized that students from the present study' research group often undertook intensive and moderate activities, therefore it resulted in a higher total energy expenditure compared to the students of tourism and recreation. Differences may be caused by dissimilar profiles of students education.

CONCLUSIONS

1. The students showed different levels of physical activity, which significantly affected anthropometric parameters and their body composition.
2. The program of biotechnology (Faculty of Biology and Environmental) should include topics on regular and targeted physical activity.

3. Further studies of body composition and level of physical activity of different learning profiles' students are needed.

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