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Assessment of the Level of Somatic Indexes, Aerobic Capacity, and Physical Activity of Young Women

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Abstract

This study rates the values of anthropometric parameters and somatic factors (such body fat percentage, water percentage, BMI, and aerobic capacity based on the VO_2 max index) among female students (n = 548).

The purpose of the study is to rate the values of physiological parameters characterizing health, including anthropometric parameters, body tissue components and physical efficiency of young women.

Keywords: Health indicators; Physical activity; Students

Abbreviations: IT: Interval Training; CT: Continuous Training; AIT: Aerobic Interval Training; CME: Continuous Moderate Exercise; CVD: Cardiovascular Diseases; FAT: Fat Content Index; BMI: Body Mass Index

Introduction

Physical activity is an integral part of a person's lifestyle, an element of their behavior towards their own health. Movement, work, effort, and related energy expenditure are inherent aspects of human activity, characterizing their active relationship with the external environment. From a physiological point of view, physical effort is defined as the work of skeletal muscles along with an entire ensemble of accompanying functional changes in one's body [1,2]. Sports as well as recreational and tourist activities play an important role among the various forms of physical activity [3]. An appropriate dose of physical activity, in addition to healthy nutrition, is necessary to maintain an optimal level of physiological indexes that characterize health, especially physical performance, body composition, and lipid profile [4-6].

Systematic physical activity has a positive effect on the body and helps to obtain health-enhancing values. Potential values include, among others, an increase in the body's physical capacity, the occurrence of vagotonia symptoms such as slowing down the resting rate of heart contractions or sparing work of the respiratory system, maintaining the desired blood hemoglobin levels, reducing excessive body weight as well as the amount of subcutaneous adipose tissue, and enhancing the strength of muscles stabilizing the spine [7]. Increased physical capacity, lowering the concentration of catecholamines during exercise, increased antioxidant system activity, and the calming effect among exercising people are also benefits of systematic physical activity, which are important in cardiological prevention [8]. It has been demonstrated on numerous occasions that low physical activity coexists with obesity, osteoporosis, back pain, circulatory diseases, carbohydrate and lipid metabolism disturbances, and various psychosocial problems [9].

Hypokinesia is one of the sources of the obesity epidemic [10] and the accompanying metabolic syndrome [11]. Low physical activity among adolescents at the age of puberty contributes to the development of obesity [12]. The authors dealing with this problem emphasize the influence of physical activity on the energy profile of women [13]. Physical effort has a positive effect on the locomotor system: it increases muscle mass and strength, strengthens and stabilizes joints, increases their range of motion, strengthens the muscle attachments, tendons, and ligaments, and prevents joint degeneration [14]. It causes proper bone mineralization [15,16], prevents posture defects, and helps

to correct them [17]. Systematic physical activity is a guarantee of physical and mental health [18,19]. A healthy lifestyle related to reduced smoking, alcohol consumption, and a proper diet and physical activity has a positive effect on the blood lipid profile and prevents the development of cardiovascular diseases [20]. Regular physical training increases physical efficiency and slows down the reduction of VO_2 max index among physically active people, compared to people who prefer a sedentary lifestyle. Between the ages of 30 and 50, the reduction of VO_2max for inactive people is about 10% per decade, compared to only about 1% per decade in the case of active people. Moreover, even a slight increase in VO_2max by 3-4 ml/kg/min may extend the period of physical fitness and independence by 6-7 years [21]. Systematic, high-intensity physical exercises with elements of Interval Weight Training lead to greater changes in anaerobic and aerobic capacity, as well as to a more favorable modification of anthropometric and biochemical indexes, compared to low and moderate-intensity endurance exercises [22,23]. On the basis of the presented theses of the above-mentioned authors, the following conclusions can be drawn: an appropriate level of physical activity is the basic condition for maintaining proper physiological functions of the body and maintaining health, whereas a low level of physical activity increases the risk of incidence and mortality. Polish society is characterized by low physical activity. It can be estimated that only about 30% of children and adolescents and 10% of adults practice forms of exercise, the kind and exercise load intensity of which meet the physiological needs of the body [24]. Although the percentage Poles who exercise regularly is higher than was 10-15 years ago, 50-60% of adult Poles are still too little physically active. Almost 35% of participants of the WOBASZ study (37% of women and 32% of men) do not perform physical exercises lasting more than 30 minutes a day during their free time from work and study [25].

The research results concerning the physical activity of students are also not optimistic [26]. Research by Umiastowska & Pławińska [27] shows that about 10% of students do not undertake any physical activity in summer, and over 40% in winter - when there are no physical education classes at universities, during the End-Of-Term examinations, and the inter-semester break. Also, every fifth university student from Poznań (20%) does not declare any form of physical activity, and 19% reports only occasional participation [28]. Sports activities in their free time are undertaken by approximately 36% of students of universities in Kraków [29]. Compared to the above values, the systematic sports activity of students in Warsaw is quite high [30]. Nevertheless, the sport and recreational activity of pupils (62%) and university students (56%) is much higher than that of the rest of society and is similar to the sports participation level of young people from all highly developed countries, such as the USA or Sweden [30].

For students, motor activity is an important factor in achieving the desired state of positive physical health. This proves the need to promote and facilitate the participation of academic youth in various forms of physical education [31]. The European Union's guidelines on physical activity try to use motor activity as a means to fight numerous diseases of civilization and lead the way by proposing means of proceeding - among other places - at universities, by promoting health among their students. Contemporary times require a diagnosis of the current state of student physical culture at universities and designating new directions of activities within it. There is a need to change the goals of university physical education by influencing the awareness and attitudes of students towards their active participation in physical culture. One of the tasks of physical education teachers at universities is to inspire university authorities to implement programmes that provide this opportunity.

The Bologna Process, of which Poland is a signatory, even imposes an obligation to change the quality of education at universities, including, of course, changes in physical culture in those places. In the era of European integration, new educational challenges require an innovative and multidimensional approach to educating students, including education in physical culture. The Centre for Physical Culture of the Maria Curie-Skłodowska University in Lublin bases its activity on current research in the field of physical culture of students, so that the didactic classes offer is innovative, adapted to the expectations and interests of students [32]. In order to increase the offer's attractiveness, it seems necessary to expand it. The subjective - rather than objectifying - treatment of students became the main motive for undertaking decisions regarding changes. It is very important to work on improving students in certain sports skills and to teach them about the importance of physical activity for health and life. Students should be convinced that the habits they learn during physical education will help them stay fit and healthy in the future. Recent studies show that the physical education of students should be health education, and at the same time, the physical culture of students should be perceived from the point of view of their future professional roles [33]. University studies are a time when one can be provided a minimum of knowledge about pro- health behaviours, be shown a variety of sports disciplines and forms of exercise, learn basic technical and tactical skills, familiarize oneself with the rules of the competition, and be presented with the principles of training (mainly health training), in popular or alternative forms of physical culture [34]. Students are a group of society that will be actively involved in professional life in a few years, therefore it is worth monitoring their health in the diagnostic and prognostic senses. The inspiration to research for this study are the facts resulting from the statements of the previously cited authors regarding the health and physical activity participation of students at Polish universities.

The aim of the research was to assess the physiological indexes characterizing health, including anthropometric parameters, body tissue components, and physical capacity of first- year female students at Maria Curie-Skłodowska University. The results of the

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research, intended by the authors of this study, were to answer the following research questions:

a) What results in terms of anthropometric indexes and tissue components have the students participating in the research obtained?

b) What is the capacity for maximum oxygen consumption (VO_2max) of the female students participating in the research?

c) How are the obtained values of health indexes compared to female students from other academic backgrounds?

Material and Methods

Recruitment of research participants was carried out during the first-year students physical education classes at the Maria Curie-Skłodowska University in Lublin. Participating in the research was voluntary. The condition for participating was a health declaration and not using any pharmacological treatments. 548 women participated in the study. People who declared participation in the research programme were informed about the topic, research purpose, methodology, and expected results. The characteristics of the participants are presented in Table 1. The research tasks were performed on January 14th-18th, 2019. For every female student (n = 548), measurements of anthropometric parameters, body tissue components, and maximum oxygen consumption (VO_2max) were taken according to the developed methodology.

Table 1: Characteristics of the participants.

Participants	Age	Body Height	Body Mass
n = 548	(years)	(cm)	(kg)
x	19,57	165,19	60,77
SD	0,66	5,87	10,92
Max.	21,0	184,0	110,80
Min.	19,0	149,00	40,50

Following research methods were used:

a) Personal questionnaire plus IPAQ physical activity questionnaire [35]. Measurement of anthropometric parameters: height, body weight, and body composition. Body Mass Index (BMI = (body weight in kg)/ (height in sq. m) was calculated from the obtained measurements. Body composition was assessed by the bioelectric impedance method (using a body composition analyzer by Tanita SC330, Japan), where Fat-Free Mass (FFM), fat tissue content (FAT), and Total Body Water (TBW) were determined [36].

b) Estimation of the maximum oxygen consumption (VO_2max) was made on the basis of an indirect method based on the Norwegian version of the Beep-Test (also known as the Maximal Multistage 20m Shuttle Run). The test consisted of performing a maximum number of running sections over a distance of 20 meters in a sports hall. The rhythm and pace of the run were determined by the test programme with an acoustic signal (Norwegian Beep-Test application) from a CD. The participants ended the test by "refusing" or failing to reach the 20m line twice before the acoustic signal. The last section of the run allowed for the determination (according to a table) of the expected VO_2max level achieved (in ml/kg/min) [37].

The obtained results were analyzed statistically - with the use of descriptive statistics - calculating arithmetic means (x), standard deviations (SD) as well as the minimum (min) and maximum (max) values. All calculations were performed with the use of the SPSS programme ver. 21. [38,39].

Results

The research results are presented in Table 2. The mean value of the maximum oxygen consumption index (VO_2max) among the examined female students was 29.04 ml/kg/min, the max value reached 46.80 ml/kg/min, while the min value was 17.90 ml/kg/min. The average value of adipose tissue percentage among the participants was 24.47%. However, the values of max and min of this index were, respectively, 49.20% and 8.1%. The average value of the BMI index was 22.19 and the max and min values were 40.40 and 15.6, respectively. The mean percentage of the respondents' Total Body Water amounted to 53.08%. However, the values of max and min reached, respectively, 73.80% and 37.40%. The average value of the weekly physical activity energy expenditure, determined by the respondents in the IPAQ questionnaire, was 2155.67.

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Table 2: Average values of health and physical activity indexes obtained during the research of female students.

N=548	VO_2max [ml/kg/min]	FAT [%]	BMI	TBW [%]	Physical Activity Energy Expenditure [MET- at Least One Week]
x	29,04	24,47	22,19	53,08	2155,67
SD	4,80	7,75	3,90	4,92	1410,65
Max.	46,80	49,20	40,40	73,80	4678,06
Min.	17,90	8,1	15,6	37,40	198,54

Discussion

In population studies, overweight and obesity are often identified and assessed using the Body Mass Index (BMI), which is calculated as weight in kilograms divided by the square of height in meters [40,41]. It is also emphasized in the literature that the BMI index reflects the ratio of body weight and height and does not reflect the proportion between body weight and its composition. Therefore, in order to correctly assess the relative body weight, BMI should be related to the percentage of adipose tissue [42]. The participating female students had correct BMI values at the level of 22.19. This is very beneficial because people with high BMI and WHR values are at a high risk of developing metabolic diseases (obesity, type 2 diabetes, metabolic syndrome), as well as at risk of cardiological death in a later period [43].

In the authors own research from 2010 [44], BMI values among the examined women ranged from 21.04 to 22.95; that is, within the standards recommended by the WHO [45]. Studies of female students from universities in Rzeszów indicate average BMI values at the level of 21.0 [33], female students from Poznań - 21.9 [46], while female students from the University of Physical Education in Warsaw had an average BMI value of 21.8 [47]. In a study of female students of the University of Physical Education in Wrocław, the average BMI value was 21.3 [48]. Currently, obesity and the associated incidence of hypertension, type 2 diabetes, and metabolic syndrome, as well as mortality related to the above-listed factors, are a serious problem in Europe. Eastern European and Mediterranean countries show a greater prevalence of obesity and incidence compared to countries from Western and Northern Europe [49-51]. Similarly, in the United States of America, Australia, and other highly developed countries, there is an association between the lack of regular physical activity and the increased risk of obesity and cardiovascular diseases, which are the main causes of morbidity and mortality among women and men [52,53]. In order to reduce the risk of diseases resulting from a low daily dose of physical activity, intervention programs aimed at increasing the physical activity of adults and adolescents are being introduced [54,55]. To address this important public health problem, the American College of Sports Medicine recommends equalling the energy balance by combining a reduction in energy consumption and an increase in energy expenditure. The means to achieve these goals should be an appropriate structure of exercise and various forms of physical activity as well as fat consumption reduction, leading to an energy deficit of 500-1000 kcal/day [56].

The surveyed female students obtained average body fat content index (FAT%) values at the level of 24.47%, while their peers from Rzeszów during cross-sectional studies obtained a value of 22.6% [33]. On the other hand, for students from the University of Physical Education in Warsaw with low and high energy expenditure, the average values of this index were, respectively, 24.7% and 23.2% [47]. Data presented by Stachoń et al. [48] from research of female students at the University of Physical Education in Wrocław show that the percentage of adipose tissue depends on the intensity of physical activity. Students declaring high physical activity were characterized by lower FAT% values than their friends who showed medium and low physical activity. When assessing selected parameters describing the level of aerobic fitness, it should be remembered that during the tests, this area of fitness was checked based on the Beep-Test. VO_2max values obtained in the study (29.04 ml/kg/min) indicate very low oxygen consumption according to the A strand classification. For comparison, Slovak students from the Universities of Prešov and Košice reached VO_2max values of 34.4 and 34.7 ml/kg/min, respectively [58]. In a study from 2010 [44], female UMCS students had an average VO_2max value of 36.2 ml/kg/min.

Research results indicate that people with low VO_2max levels (<29.1 ml/kg/min) are almost seven times more at risk of morbidity due to metabolic syndrome than those with higher VO_2max (≥ 35.5 ml/kg/min) [58,59]. The studies of many authors confirm that there is a stronger negative correlation between aerobic fitness and the occurrence of cardiovascular diseases (CVD) than between the volume of physical activity and CVD [60,61]. The relationship between deaths from cardiovascular causes and maximum oxygen consumption (VO_2max) is also known [62,63].

In order to improve the maximum oxygen consumption index value for female students, a physical education programme related to higher physical activity energy expenditure should be introduced. The results of the authors' own research confirm that taking part in as little as an 8-week-long recreational training 3 times a week, in a session of 50 minutes, improves the VO_2max index by 15% [44]. Other authors observed almost identical increases in the VO_2max index: 15% as a consequence of interval

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training (IT) and 9% in continuous training (CT) lasting 8 weeks [64]. Studies described in source literature confirm that the effects of aerobic interval training (AIT) are similar or higher compared to continuous moderate exercise (CME) when it comes to shaping VO_2max levels. [65,66]. The time structure of an AIT training session may be shorter than that of a CME one, as the applied high-intensity exercise increases physical activity energy expenditure. Typically, similar VO_2max increases can be obtained when the AIT training time is shorter by about 15-20% compared to the CME training. After equalizing the physical activity energy expenditures during AIT and CME trainings, greater increases in VO_2max levels are noted more often in the AIT training group [67,68].

Data from the literature show that supplementing physical education classes with a single session of HIE or CME exercises positively influences the effectiveness of the academic physical education programmes, it also brings additional benefits in the form of improving somatic and endurance indexes, and thus is the basis for a positive prognosis of the programme participants' health condition [69]. The academic environment is a suitable place to implement and test the effectiveness of various forms of recreational training as a strategy for reducing cardiovascular risk factors. Research findings support the idea of supplementing regular exercise in physical education with just one supervised training session, based on both CME and HIE, for additional health benefits [70,71].

Conclusions

Based on the analysis of results presented in this study, the following conclusions have been drawn:

a) The obtained results describing the values of anthropometric indicators and tissue components of the participating female students are at the level of normative results and similar to the results reached by female students from other academic environments.

b) The maximum oxygen consumption index (VO_2max) value of the participating female students is at a very low results level and differs from the values obtained by female students from other Polish universities.

c) In order to improve the aerobic fitness of students, the academic physical education classes curriculum should be modified, among other thing, towards a greater volume and intensity of training measures.

In order to increase student participation in physical activity, educational programmes informing about the scale of health problems resulting from the lack of an appropriate dose of physical exercise should be implemented.

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